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December 27, 1928

Engineering News-Record

Devoted to Civil Engineering and Contracting

A Year's Experience Operating Holland Tunnel

By OLE SINGSTAD

Chief Engineer and Superintendent

An intimate and precise account of what has been learned in handling the continuous heavy traffic which has flowed through the tunnel since its opening on Nov. 12, 1927. The forecasts and assumptions of the designing engineers have been confirmed. The ventilation has proved highly successful. A large net income promises even more rapid amortization than was anticipated in the planning.

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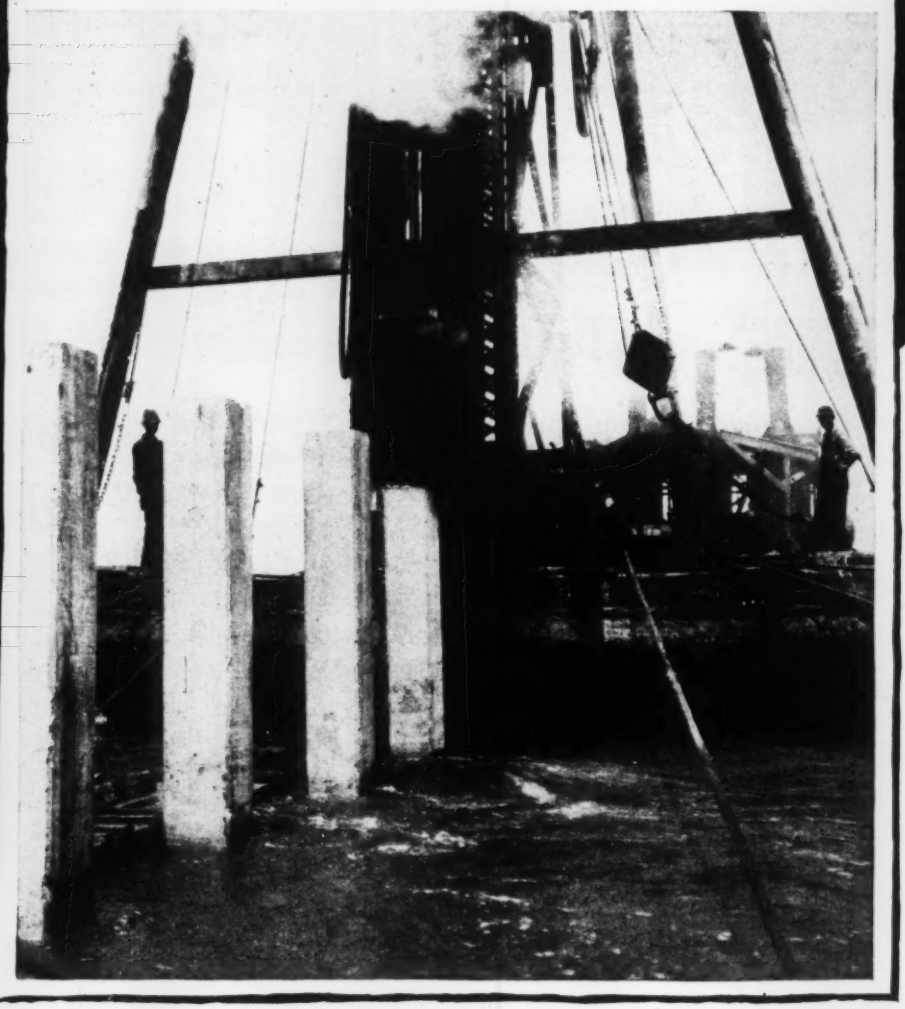

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Volume 101 NEW YORK, DECEMBER 27, 1928 Number 26

Warnings from Olean

PRECAUTIONARY measures in common use and readily employed at small cost would have materially lessened if not entirely prevented the recent water-borne epidemic of typhoid fever at Olean, N. Y. So simple and inexpensive a means as daily tests for residual chlorine in the emergency water supply not only would have shown that more chlorine was needed but would have indicated dangerous pollution as well. The sudden outburst of diarrhea in August would have warned competent health and water authorities of serious danger; and, even though themselves ignorant or laggard, had they reported the diarrhea to the state health authorities, as legally required, both a warning and an investigator from Albany would have been quickly forthcoming. The futility of requiring that all local health officers in New York must be doctors of medicine instead of requiring that they be competent health administrators is attested by the Olean epidemic. The outbreak again calls attention to the danger of carrying a water supply in a conduit laid on the bed of a polluted river. The present-day infrequency of water-borne typhoid epidemics should be all the stronger incentive to water and health authorities to spare no pains to detect and remove such dangers as in this instance caused some 230 cases and twenty deaths from typhoid—in a community of less than 25,000. The more infrequent water-borne typhoid becomes, the less excusable every occurrence of the kind.

Lost Time Again

LOST TIME continues to be a large item in the cost of roadbuilding. When, a few years ago, the Bureau of Public Roads in its time studies of concrete paving operations disclosed large time losses, the excuse was offered that practice was in a state of flux: the material was comparatively new, design and structure of pavement were continually changing and equipment and procedure were being altered every season. There was justice in these contentions, and there still is force in the argument that change is continuing. But they did not then, nor do they now, account for the delays and the waste time which continue to increase the expense of concrete roads. Further evidence that lost time is due to more fundamental causes than arise from standardizing a new type of construction appears in recent figures on time losses in asphalt road work. Whatever may be asserted of concrete, asphalt is in no possible sense a new paving material or process, and plant and working procedure have remained virtually constant for years. Yet asphalt road builders are apparently no more capable in keeping down time losses than concrete road builders have been. From the time loss figures mentioned it appears that lost time is chiefly chargeable to bad weather, to equipment breakdowns and to management; and that management delays predominate. In a continuous spell of rain, weather delays outnumber all delays, but with management delays a close second; in favorable weather, management delays surpass all others. The remedy is plain, as it is also in the study of concrete road construction. Road and street paving work needs primarily better construction practice. This is a far more important requirement than better materials.

A Disquieting Failure

FULL and final determination of the causes responsible for the collapse of the large and almost new bascule bridge over the Hackensack has not yet been reached, but on all accounts it is a most disquieting accident. The evidence strongly, if not convincingly, points to a structural failure. Yet steel bridge construction is one of the most thoroughly developed arts of modern engineering, one in which stress calculation and exact proportioning of material to service are carried much farther than in other branches of the structural art. Moreover, the test of practice places in our hands many checks on theory, and experience in maintaining steel bridges makes it possible to discover and correct defects revealed by the pounding of traffic. In view of these conditions, when a new bridge of modern design collapses without the slightest warning and in the absence of external attack, bridge engineering finds itself under indictment. The situation is of greater gravity because one part of the bridge on which primary suspicion rests is a guide frame which did not carry load stresses and yet was exposed to complex sets of deformation effects and other secondary actions. To clarify the relation of such elements to the strength of the bridge structure is of basic importance. Fortunately an able board of engineers has been named to investigate the accident. It is to be hoped that their study of the case will be thorough and searching in the extreme and go beyond the mere immediate factors of causation and responsibility. It is essential that bridge-building practice be fully cleared of the indictment and that it once more be placed beyond suspicion.

Air Field Surfaces

A REAL challenge is presented to the airport engineer by the growing number of transport planes of large size and weight that are being placed in operation. What kinds of field surface can he provide that will withstand the pounding of these immense ships? The huge trimotored twenty-passenger Keystone monoplanes, said to be the largest commercial planes yet placed under construction, weigh in excess of 8 tons when fully loaded. Unfortunately the first of these to be completed was recently destroyed by fire, but three others now in various stages of manufacture promise soon to be in operation. An almost equal weight is attributed to the eighteen-passenger Boeing planes operating on the Pacific Coast. The all-metal Fords are in the 10,000-lb. class, while the new fourteen-passenger Fokkers and the Sikorsky-Curtiss

amphibians are only slightly less heavy. Add to these weights the impact forces of poor landings and the engineer is seen to have a serious problem of runway design to solve. On our highways we have been able to distribute heavy loads on numerous wheels, while in soft ground such heavy machines as tractors, power shovels and even motor trucks are able to resort to the low unit-pressure crawler. But so far the airplane's landing weight is concentrated on its two rubber-tired wheels, although the tail skids or in some cases rear wheels must carry as much as a third of the weight in the rare case of a perfect landing. Construction and economical maintenance of landing-field surfaces are among the important problems which the airport builder must solve. There is a serious lack of accurate information on possible load concentrations and effect of impact. But a close enough approximation of these factors can be made to serve as a basis for tests on various surfaces and sections of runways. It is not too soon to inaugurate constructive thinking and action on some of the fundamentals of airport designing.

Welding Inspection

THE question of what is a good weld and how it may be recognized arises in nearly every discussion of the possibilities of structural welding. The trouble is not with lack of an answer, but with the wide divergence of current opinions and belief. Unfortunately, none of these various opinions is based upon sufficient facts. It is in part true that, as some welding enthusiasts charge, the engineers who oppose structural welding on the ground that it cannot be properly inspected overlook the fact that inspection in no field is perfect—that mechanical or physical determinations are at best only fragmentary evidence. But at the same time welding engineers often forget that proof of satisfactory inspection methods lies wholly with them; at least, to date their activity in furthering methods of inspection have not been particularly evident. However, at a recent meeting of the American Welding Society, C. D. Jensen, of Lehigh University, described an interesting investigation of welding inspection, whose aims might well be emulated on a wide scale in the welding industry. Briefly, he attempted by actually examining a large series of welds to find a set of rules that would measurably cover the requirements of welding inspection. Poor welding as well as good welding was done, and all welds were inspected by a senior engineering student. Professor Jensen reported that this inspector-apprentice soon developed surprising accuracy in judging welds visually by such qualities as porosity, neatness, spatter, fusion, overlap, and size and depth. Still greater accuracy was found to result when the inspector could see the bead run, hear the arc and watch the ammeter and voltmeter. The main importance of these tests is that they demonstrated a commendable curiosity on the part of their promoters to learn how to inspect structural welding; the data on visual inspection may be considered virtually a byproduct. That sight and hearing, the two senses which have been relied upon for years in inspecting riveting, are able to perform so well in weld inspection is most interesting, and justifies the hope that visual inspection may prove as dependable as in the field of riveting. After all, it should not be impossible to find an inspection method for welds that will be as satisfactory as listening for the metallic ring of the test hammer on a loose rivet head. The great requirement is for more authoritative inspection tests.

The Future of Vehicular Tunnels

A LITTLE more than a year has elapsed since the Holland Tunnel under the Hudson River at New York was opened to vehicular traffic. At that time all the plans for ventilation, for traffic control and for the safety of the public while in the tunnel were essentially academic, being the outgrowth of theory, the result of months of study and research, but as yet untried. The tunnel was entirely novel; no precedent existed on which to base the design of the operating facilities. Today those theories have been put to a year's test. What was supposition then is fact now. Consequently a resurvey of what has been found from the results of this first year of operation is in order. It is given by the chief engineer of the tunnel in the following pages.

Ventilation, of course, was a most important operating problem to be dealt with on account of the insidious poisoning quality of the carbon monoxide gas given off by motor vehicles. Exhaustive tests showed that a concentration of 4 parts in 10,000 was the maximum which should be allowed, and other studies indicated that a system of transverse ventilation would give a more uniform distribution of fresh air in the tunnel than would a system of longitudinal ventilation such as used in railway tunnels and subsequently in the Liberty vehicular tunnel in Pittsburgh. The quantity of air required to obtain the desired dilution and the amount of power necessary to move it through the long ventilating duct presented an added unknown to be approached by further experimental work.

Other details which had to be worked out beforehand were a system of traffic control suitable for the narrow roadways, methods of collecting tolls that would not limit the capacity of the tunnel, and means of fighting fire in the tunnel.

Now, on the review of experience, it is shown that operating results confirm the plans and estimates with remarkable precision. This satisfying outcome is a clear indication of the accuracy of the work of the many engineers involved in the preliminary studies. On the opening day—the busiest day in the entire year's operation—with the normal arrangement of two of each set of three ventilating fans operating to full capacity, the maximum concentration of carbon monoxide gas was only 1.6 parts per 10,000. This was with a total hourly number of passenger vehicles less than 100 short of the estimated maximum hourly capacity of 2,540. With a mixed traffic of trucks and passenger cars these results and those of the present ordinary daily traffic indicate that the ventilating system has a large effective margin and will be adequate for a traffic made up entirely of loaded motor trucks.

The peak load of passenger traffic on the opening day fell a little short of the estimated maximum, but with the toll collecting and traffic control adjusted to smoother operation it is now possible to handle that maximum of traffic. The maximum mixed traffic figure has never been reached, but present indications are that this also is approximately correct. Few vehicles have found the grades too steep to operate at a reasonable speed, but it is evident that the present grades are close to the point where grades will become the limiting capacity factor for heavy trucks.

The plan of having traffic control centered in a central control office has proved itself highly desirable because by that system both tunnel plazas and every section of the tunnel can be kept advised of conditions quickly and traffic jams prevented.

The year's experience has shown that the fears which some few had entertained as to the possibility of panic from fire in the tunnel are unfounded. In the twelve months that have elapsed, 192 fires have occurred in the tunnel and none has resulted in anything approaching a condition of panic. The fire-fighting arrangements have proved to be adequate for all emergencies.

In any undertaking of this character the economic factor is of prime importance. Few engineers doubted that such a tunnel could be built. Whether it could be built and operated at a profit was not assured. The engineers of the Holland Tunnel concluded from their cost and traffic studies that they could. The financial return at the end of the first year shows that their deductions were correct despite the increased construction cost.

There is every indication that we are at the threshold of a period of intensive vehicular tunnel construction. The Oakland Estuary tunnel, modeled after the Holland Tunnel, has been in operation for a short time. Other subaqueous tunnels are under construction at Detroit and at Liverpool. Still others are projected. Whether or not they will be undertaken in the near future depends in a measure upon how successful the present tunnels are found to be. For that reason the results of the first year's operation of the Holland Tunnel are of world-wide interest. They presage a great impetus to the development of vehicular tunnels.

Prequalification Demands Definition

MUCH current discussion is concerned with the theme of prequalification of contractors. The practice is not new; the novelty is that it has recently been made association propaganda by contractors. Prequalification has been required for years by private owners, industrial corporations, public service companies and public-works bodies. The present interest in prequalifying contractors concerns the use of the method in public work by federal bureaus, states and municipalities. These contracting agencies are bound by law to place primary stress on contract price, for the lowest responsible bidder, by public law and ordinance, must receive the contract. There are obvious hazards in the requirement, especially as responsibility has too much been considered to mean only financial ability and backing. This is the situation that has led contractors' associations to push a movement to require prequalification. They have strong arguments in justification of their activity.

Meanwhile there is vagueness as to precisely what is meant by prequalification. In Wisconsin, where the practice has been very successful, contractors must go before a qualifying board of the highway department, where they are classified and accredited before they can submit bids. In other states it is required that all bidders for highway construction shall fill out a comprehensive questionnaire, upon the showing of which and from other knowledge the contracting official may disqualify a low bidder. Again, we have the recent ruling of U. S. Comptroller-General McCarl on federal public works, which virtually requires that to warrant a rejection of the low bid the call for bids must state "the requirements for a showing of the qualifications of the bidder." Virtually the qualifications for bidders are required to be specified.

There is an essential difference in these practices not only in method but probably in legality and certainly in justice. Comparisons need not be enlarged upon at this time. The important fact to be noted is that prequalification is not a definite term as it is being used. Logically it can mean only determination of the right of the contractor to offer to do construction in a specific instance. To allow the contractor to bid on the requirement that he fill out a questionnaire and then disqualify him on the showing of his answers is neither logic nor justice, unless the requirements for passing answers are distinctly stated in the call for bids. The demand and the need for some selective method in receiving public-works bids are too reasonable to be urged on indefinite terms.

With all that may be said in favor of prequalification, it has to be kept in mind that open competition and reward for making the lowest bid are sound public-works contracting policy. The burden of proof that a low bid is unwise and hazardous to the public welfare must therefore rest on the awarding official. He will be wise, then, to protect himself by definitely stating in his call for bids the conditions he will impose on bidders and the qualifications he will demand.

This is the only fair attitude toward the contractor and toward the work alike. Good engineering requires us to be definite in every detail of contract and specifications. We should be no less than definite in calling for proposals to undertake contracts.

A Momentous Decision

DURING the week Congress passed and the President promptly signed the bitterly contested measure for the control of the Colorado River. Events moved rapidly since the favorable action of the Senate on Dec. 14. Even before our last issue left the presses, the House of Representatives accepted the amended bill as just passed by the Senate, and a few days later the President approved it. So ends a long campaign for one of the greatest public-works projects of the day. The Boulder dam bill has become law.

The government's decision is momentous. Complete regulation of the flow of a great river—a primary need of the Colorado situation—is to be undertaken; for the first time the federal government takes upon itself such regulation. Its action in large part rested on the compelling reason that the delta region must be freed of the menace which now overhangs it; nevertheless a most important precedent has been set. To pay for this regulation, power-development profits are to be drawn upon, so far as they are realized.

Of even greater moment, perhaps, is the meaning of the decision on the power question, since the involvement of power and the allocation of the expected power profits formed one of the great fighting points of the project. Enactment of the law implies the view, on the part of the government, that power production, flow equalization and water conservation are logical parts of an inseparable whole in this instance, to be considered jointly both in the conception of the project and in the evaluation of its economic factors. The question here at issue is only in part of strictly engineering character, as we remarked on previous occasion; to an important degree it is a policy matter, a proper subject for legislative decision on broad grounds of national attitude. Congress has declared that, in such a case as this one, the power phase shall not be carved away from the other phases of the problem, and shall not be entitled to have its profit or loss accounting segregated. That this policy has been determined by the enactment is in some respects the most significant features of the new-made law.

A Year's Operating Experience With the Holland Vehicular Tunnel

Heavy Traffic Handled Without Difficulty—Ventilating System Found to Be Adequate—Little Movement of Tubes in River Silt—Substantial Net Return From First Year's Operation

By Ole Singstad

Chief Engineer and Superintendent, New York State Bridge and Tunnel Commission and New Jersey Interstate Bridge and Tunnel Commission

TRAFFIC IN FREEMAN SQUARE, NEW YORK, ENTERING THE HOLLAND TUNNEL

The toll-collecting booths are set in a semicircle around the entrance roadway in order to accommodate traffic approaching from the four corners of the square.

THE Holland Tunnel, connecting downtown Manhattan with Jersey City, forms the first link between the highway systems of New York and New Jersey across the Hudson River. It was opened to traffic on Nov. 12, 1927, and this article will review briefly the operating experience of the first year.

From time to time *Engineering News-Record* has contained articles describing the tunnel project and the construction progress in its various stages, consequently merely a brief description of its traffic facilities and ventilation system will be given here.

The tunnel consists of two tubes, each with a roadway 20 ft. wide between curbs, accommodating two lanes of vehicles in the same direction. The north tunnel is for westbound and the south tunnel for eastbound traffic. The entrance and exit on either side are separated by a distance of two city blocks to minimize traffic congestion, and entrance and exit plazas are provided as indicated on the plan shown herewith. Tolls are collected from the vehicles using the tunnel, and the entrance plazas are provided with facilities for the collection of tolls at those points.

Ventilation System—The ventilation system of the tunnel is novel. It was developed especially for the Holland Tunnel after extensive research work in connection with the design of the tunnel, and has never before been used for tunnel ventilation. For this reason it has attracted unusual attention, not only among engineers but on the part of the general public as well. The operation of this system under heavy traffic conditions was therefore looked upon by many as of the greatest importance in determining the future development of vehicular tunnels.

The tunnel is ventilated by a transverse method of ventilation, eliminating all longitudinal flow of air in the roadway except that set up by the moving traffic. Fresh air is supplied throughout the entire length of the tunnel from a main supply duct under the roadway, and the vitiated air is withdrawn through frequent openings in the ceiling into a similar exhaust duct above. Each tunnel is divided into seven sections for ventilation purposes, and a corresponding number of sets of blower and exhaust fans, located in four buildings, ventilate the tunnel in fourteen independent sections, making a total of 28 duct sections, each duct having three fans, two of which are designed to be operating at full speed to provide the necessary ventilation at capacity operation. The third fan on each duct section is kept in reserve as a spare. Under this plan it was estimated that a total of 3,760,000 cu.ft. of fresh air per minute could be sup-

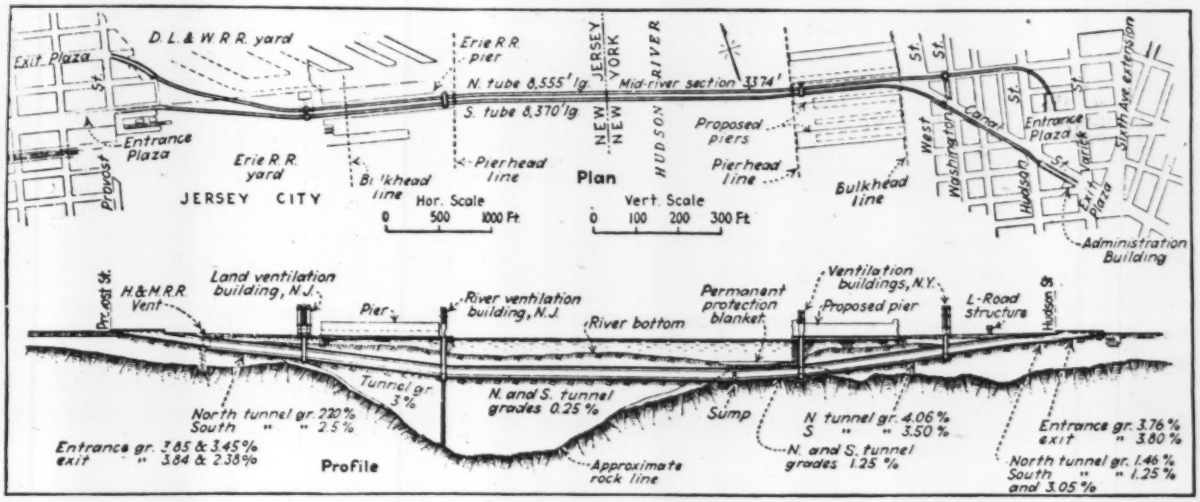
plied to the tunnel. This was based on a concentration of carbon monoxide not exceeding 4 parts in 10,000 parts of air at capacity operation.

Operation—Prior to the opening of the tunnel, toll rates and traffic regulations were adopted, briefly summarized as follows:

Motorcycle	$0.25
Passenger automobile up to seven passengers	0.50
Bus	1.00
Truck up to 2 tons carrying capacity	0.50
Truck 2 to 5 tons carrying capacity	0.75
Truck 5 to 10 tons carrying capacity	1.00
Semi-trailers 5 to 10 tons	1.25
Semi-trailers 10 to 15 tons	1.50

These rates correspond to those charged by the ferries operating across the Hudson River in the vicinity of the tunnel. The fact that the tolls are in round numbers has facilitated toll collection and has been an aid in speeding up traffic.

Special permits are issued under certain conditions to vehicles exceeding 10 or 15 tons capacity or having a side overhang beyond the rim of the wheel in excess of



PLAN AND SECTIONAL ELEVATION SHOWING GRADES AND ALIGNMENT OF THE TWO TUBES COMPRISING THE HOLLAND TUNNEL

9 in. or wider than 8 ft., or more than 12 ft. in height and specified lengths for various types of vehicles. Axle loads are limited to 12 tons.

Horse-drawn vehicles and vehicles having metal tires are excluded from the tunnel. Commodities such as explosives, inflammable or corrosive liquids or poisonous gases or liquids are also excluded.

The following are the more important regulations affecting drivers:

Speed in the tunnel is not to exceed 30 m.p.h.

No vehicle shall cross the center line or leave its lane, except when so directed by a policeman.

Vehicles are to maintain a spacing of 75 ft.

No tire changes are permitted by drivers in the tunnel.

All headlights must be extinguished upon entering the tunnel.

Traffic—During the first twelve-month period of operations ended at midnight on Nov. 12, 1928, the total number of vehicles of all kinds using the tunnel in both directions was 8,517,689, of which 78.8 per cent were passenger cars, the average daily traffic being 23,372, the average Sunday and holiday traffic 36,391, and the average weekday traffic 20,545. Of the total number, 4,271,581 were eastbound and 4,246,108 westbound.

Except for a period of a few weeks immediately following the opening of the tunnel, when a large number used it for the novelty of the experience, and allowing for the usual seasonal variation in traffic, there has been a steady increase in the volume of traffic through the tunnel. The total revenue received from this traffic, together with income from duct rental and miscellaneous revenue, gave a total income of $4,700,201.

There has been a constant increase in the percentage of commercial vehicles, so that the average toll rate has increased from 52.73c. per vehicle during the period Nov. 13 to Dec. 31, 1927, to an average of 54.97c. for the month of October, 1928. This increase has been steady and is expected to continue.

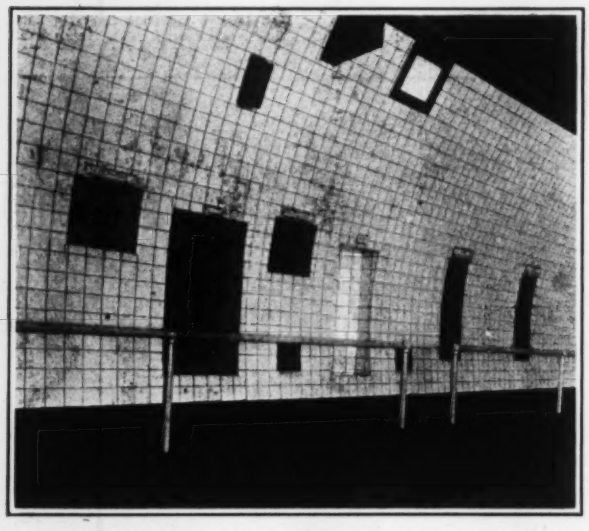
Of the total traffic crossing the Hudson River between Manhattan and New Jersey, including the traffic using the tunnel and that using the fifteen ferries extending over a distance of about 12 miles of the river, the tunnel traffic constitutes about 43 per cent. It is estimated that approximately 45 per cent of the tunnel traffic during the year was new traffic which would not have crossed the river except for the improved traffic facilities provided by the tunnel, and that the remaining 55 per cent was diverted from the ferries.

The total traffic is considerably in excess of that estimated at the time the tunnel was planned. In 1919 it was estimated that, during its first year of operation, the tunnel would carry 5,610,000 vehicles on the assumption that the tunnel would be opened in 1924 and with the impetus which the new traffic facility would give to the growth of vehicular traffic, it was then estimated that the annual tunnel traffic for 1928 would be 8,100,000.

Tunnel Roadway—The tunnel roadway, which is 20 ft. wide between curbs in the tube section and widened to 21 ft. on the approach sections, has proved adequate for the safe and expeditious operation of two lines of traffic in the same direction under all conditions. The two lanes are separated by a 6-in. wide white painted center line marker, dividing the roadway into two 10-ft. lanes. At the exits the tunnel roadway is widened to 30 ft., providing for three lanes of traffic from the portal to the point where the tunnel roadway reaches the street surface. These two stretches, each about 470 ft. in length, have the steepest adverse grades—namely, 3.82 per cent—and this widening of the roadway has proved advantageous, particularly at the New York exit, where there is some interference with the continuous movement

of traffic out of the tunnel due to the large number of pedestrians crossing at this point and due to the presence of a double-track street-car line crossing immediately in front of the tunnel exit.

There has been no shutdown of traffic in either tunnel except that the north tunnel was closed for a few hours on certain nights during which time accurate readings were taken on the distribution of the air in the various sections of the tunnel, when it was necessary to exclude all traffic due to the sensitivity of the instruments being used. During these periods all traffic was handled through the south tunnel, one lane being used for westbound traffic, and the other for eastbound traffic. It was found that with this operation the maximum speed of vehicles had to be reduced to insure safe driving, which is evidence that, for operation in both directions on the same roadway, better results can be obtained with a roadway wider than 20 ft.



TRAFFIC CONTROL POINTS WITHIN THE TUNNEL

Traffic control points are located at intervals throughout each tunnel. A recessed seat is provided for the traffic officers. Telephone, fire alarm and fire extinguishers are located in the tunnel wall close at hand, and one of the illuminated traffic signals is placed directly overhead.

The granite block pavement of the tunnel shows no indication of wear, and the light asphalt coating which was squeegeed over the surface at the time the pavement was laid has not been worn off; on the contrary, it has increased due to a partial squeezing of the asphalt filler out of the joints during hot weather. This in some places, particularly on the open approaches and the upgrades, has occurred to an extent which has made it desirable to remove some of this asphalt, a condition which could probably have been prevented or minimized by the use of more sand in the filler.

In spite of the comparatively easy adverse grades, being generally not over 3½ per cent, a very small percentage of commercial vehicles has experienced difficulty in maintaining a minimum speed of 6 m.p.h. up these grades. A few vehicles have entered the tunnel that could not maintain a speed of even 3 miles an hour on these grades. As traffic increases it will become necessary to exclude some of the very slow-moving vehicles to accommodate the great bulk of the traffic which is capable of traveling at a higher speed.

In general, the tunnel grades and curvature have not interfered with the free and speedy movement of traffic. It is apparent, however, that if much steeper grades or sharper curves than the one near the New York entrance were used, it could be done only at the expense of roadway capacity, as the speed of the traffic would necessarily be reduced.

The only clearance in the tunnel on which a considerable number of vehicles presented for passage have encroached is the side overhang beyond the rim of the wheel, which is limited to 9 in., to prevent the body or load striking the tunnel walls before the wheel is stopped by the curb. Most of these are the lighter type of trucks with large bodies built for bulky commodities. This is a point to which truck owners and manufacurers may well pay some attention, as many more vehicular tunnels will undoubtedly be built and the expense of providing the necessary clearance for such exceptional vehicles is unwarranted.

Plazas — The maximum daily traffic, amounting to 51,694 vehicles, occurred on the first day of operation, with a maximum hourly traffic in the south tunnel on that day of 2,371 vehicles. The maximum hourly traffic through the north tunnel was 2,225 vehicles. The second highest day was Sunday, Sept. 9, 1928, when 48,004 vehicles passed through the tunnel.

The tolls are collected by men at toll booths on the entrance plazas, where the driver pays his fare, either by cash or prepurchased tickets, and receives a receipt coupon with the amount stamped thereon by the cash register machine in the toll booth. The driver gives up this receipt to collectors stationed at the immediate entrance to the tunnel. The ticket collectors are traffic officers who at the same time regulate traffic, designating vehicles to their proper lane according to speed. The installation for collection of tolls at the New Jersey entrance provides for the simultaneous movement of seven lanes of traffic past this point. It has never been necessary to use more than six of these lanes at a time. At the New York entrance plaza (Freeman Square), where the traffic enters intermittently at four corners, provision was made for a total of sixteen toll collection stations distributed in a semicircle around the entrance. On no occasion has it been necessary to use more than seven of these at a time, and it is not expected that, even at capacity operation, all will be needed. The tunnel has not yet been operated to capacity and the experience up to the present time does not warrant any change in the estimated roadway capacity—that is, 1,900 vehicles per hour through each tube for mixed traffic and 2,540 per hour when all passenger cars.

On the New Jersey side the plazas have proved to be ample to handle the traffic expeditiously and will no doubt be adequate for capacity operation of the tunnel. There has been some congestion on the approaching streets of Jersey City during heavy traffic, but this condition will be eliminated with the completion of the express highway leading to the tunnel plaza now under construction by the State Highway Department and the improvement of the surface condition of certain main streets in Jersey City leading to the tunnel plazas, which work is now being done by the city.

On the New York side the large volume of tunnel traffic has been handled without undue congestion of the city streets. On the entrance plaza there has been no congestion or delay in the handling of traffic, and the facilities are considered entirely adequate for capacity operation of the tunnel. As was expected, the conditions at the New York exit are less favorable than at the three other points due to the concentration of large volumes of other traffic, vehicular, pedestrian and street

car. It is expected that this condition will be improved when the Sixth Ave. extension is completed and the subway construction work now going on in this neighborhood has been finished.

Absence of Accidents—The total number of vehicles using the tunnel during the first year is more than 8,500,000 and, the length of the tunnel being nearly 2 miles, the traffic represents about 17,000,000 car-miles. This traffic has been handled without one serious accident, a record for safety which compares favorably with that of any other highway. It is believed that this is due to the rigid enforcement of the traffic regulations, the brilliant illumination of the tunnel and the provision made for the prompt handling of stoppages in the tunnel caused by fire, breakdowns, stalled vehicles and other minor accidents.

The illumination of the tunnel is greatly aided by the white glazed tile wall surfaces. The walls of the tunnel are washed once a week. For this purpose a specially built machine is used consisting of a tractor, on which is mounted an air compressor, and a trailer. In addition to this weekly cleaning of each wall, the lower part of the curved wall on the sidewalk side in the tube section, on which dust settles more readily, is given an additional weekly cleaning by hand. This has made it possible to maintain in the tunnel a clean and pleasing appearance which would be impossible with any other type of wall surfacing.

The experience gained in operation has confirmed the correctness of the decision to line the tunnel walls with a glazed tile. The tile work has shown no signs of deterioration or any tile loosening from the wall, and the decision to pay a slightly increased cost for an unusually high quality of tile work has been amply justified.

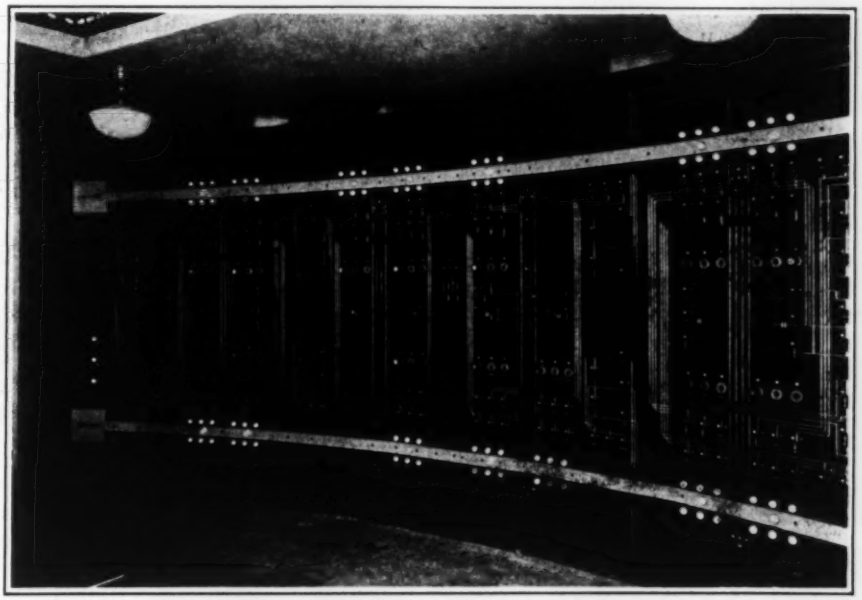
The illumination of the tunnel, consisting of lights recessed in the tunnel walls under the ceiling and spaced 20 ft. apart on both sides, has proved very effective in providing adequate illumination without the annoyance of glare. The lights originally installed were of 150-watt capacity, and while wiring was made for larger capacity lights, it has not been found necessary to increase the illumination, nor has it been deemed advisable to reduce it.

At the entrance portals for a short distance in the tunnel, the lights are spaced 10 ft. apart to provide a gradual transition from bright daylight to the standard tunnel lighting. At night alternate lights on these stretches are extinguished, as during this time there would otherwise be too sudden a change from the darker streets to the more brilliantly illuminated tunnel.

The only place where there has been any difficulty with the lighting is at the New Jersey entrance portal. Traffic approaching this portal is facing southeast, and on bright days, with the driver facing the sun, the visibility at the immediate approach to the portal is poor. This condition may be improved when the 6-ft. high parapet walls, forming part of the work of facing the open approach walls and portals with granite, are erected. This work is now in progress and if, after its completion, the condition should still exist, remedial measures can then be taken.

The tunnel and plaza roadways are cleaned every night with a mechanical pickup sweeper equipped in the front with a sprinkler to lay the dust. The sweeper travels at a speed of from 6 to 12 m.p.h. and makes two round trips through the tunnel. This method of cleaning has proved very satisfactory, and practically no cleaning of the tunnel roadway is done by flushing.

Traffic Stoppages—With the large volume of traffic handled, it was to be expected that there would be many stoppages in the tunnel for one reason or another. In anticipation of this, provision was made for the prompt reporting of such occurrences and the clearing of the roadway, restoring traffic conditions.



MAIN SUPERVISORY CONTROL BOARD IN CONTROL ROOM

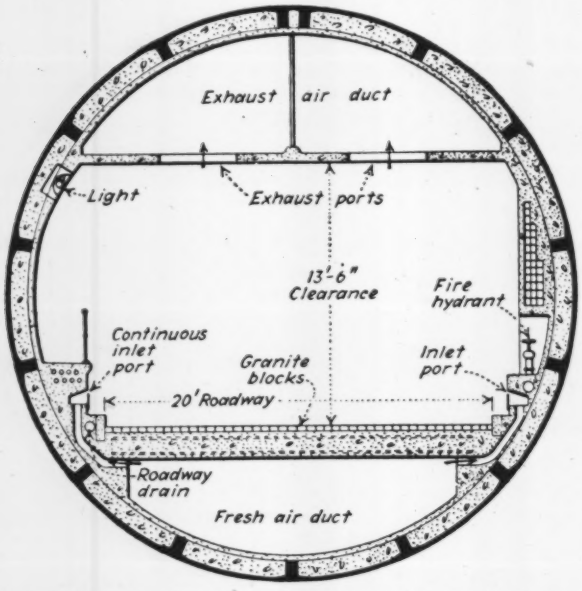
All feeder switches and fan motors are remotely controlled from this board, which, in conjunction with the traffic control board, carbon monoxide recorders and telephone board, gives the operator complete control of tunnel operation.

During the year there have been 192 fires in vehicles while going through the tunnel. All of these fires were extinguished by the policemen in the tunnel without the aid of the fire-fighting apparatus mounted on the emergency truck. One fire was extinguished with water from the tunnel water main with the use of the fire hose, and all others with the 2½-gal. and 5-gal. foam extinguishers. The great majority of the fires have been caused by overheated brakes, and in most cases the fires have been put out and one of the traffic lanes reopened within five minutes of the stoppage caused by the fire. With one exception there has been no evidence of uneasiness on the part of the public or the employees during a fire. On this occasion the gasoline fuel tank located under the driver's seat of a truck caught fire and gave the driver such a shock that he abandoned his truck and ran back through the tunnel. The tunnel police had the fire extinguished and the truck moving out of the tunnel in tow of the emergency truck within six minutes of the starting of the fire.

There have been 2,190 disabled vehicles towed out of

the tunnel by the tunnel emergency equipment; 481 towing chains, distributed throughout the tunnel, have been loaned to drivers of other vehicles to take the disabled vehicle in tow; 678 1-gal. cans of gasoline have been supplied to vehicles stalled in the tunnel for lack of gasoline; there have been 174 arrests, 1,370 summonses issued and 4,100 warnings for violations of the traffic regulations. Crossing of the center line from one traffic lane to the other has been the chief violation of traffic rules, and most of the summonses and warnings have been issued for this offense. The number of traffic violations of all kinds is, however, diminishing.

In all cases of fire, the combination fire and wrecking truck, which also carries first-aid equipment, responds, and while it has not yet been necessary to use the fire-



CROSS-SECTION OF ONE TUBE OF THE HOLLAND TUNNEL

fighting equipment on this truck, the truck, which is provided with double-end drive, is used for towing out the burned vehicle in cases where towing is necessary. For towing most of the disabled vehicles, a small tractor is used which is capable of traveling at high speed and which can easily be turned around on the tunnel roadway. This tractor is suitable only for handling vehicles that can travel on their own wheels. In cases of broken wheels or broken axles, the large emergency truck is used. There is now being developed an intermediate-sized tractor capable of lifting medium-weight vehicles and towing them out. It is expected that this device, which can travel faster than the heavy emergency truck, will still further expedite the clearing up of accidents where broken wheels or broken axles are involved. An emergency equipment station is located at each tunnel exit.

Supervisory Control System—The handling of this considerable number of traffic stoppages of various kinds without undue delay or inconvenience to the traveling public has been due in a large measure to the supervisory control system used in the operation of the tunnel. This system centers in the supervisory control room on the top floor of the administration building at the New York exit. In this room are stationed the supervisory operator and one assistant, and the telephone switchboard operator. The room contains a board on which are mounted the carbon monoxide recorders, one instrument for each of the fourteen sections into which the tunnel is divided for ventilation purposes, giving a continuous and permanent record of the carbon monoxide content of the atmosphere in each section. This recording is accomplished by drawing off continuous air samples in the ventilation buildings from the exhaust ducts. The samples are analyzed by automatic analyzers and the results electrically transmitted and recorded on the charts of instruments in the supervisory control room. These charts show the number of parts of carbon monoxide present in 10,000 parts of air. The instruments are provided with gongs which ring when the CO content reaches the prescribed limit, attracting the attention of the operator. The recording is almost instantaneous, the lag amounting to less than two minutes.

On a second board, which shows diagrammatically the power and equipment layout of the tunnel, a system of lights indicates at a glance the operating condition of the entire system. On this board are also mounted lights connected to the carbon monoxide recorders, so that when the gong rings on one of the recorders the corresponding light on the large board becomes bright, telling the operator without leaving his place the section of the tunnel in which the carbon monoxide has reached the prescribed limit. This board is equipped with keys whereby the operator starts and stops or controls the speed of any piece of equipment and closes or breaks the electric circuits. Additional air, if needed in any section of the tunnel, can thus be provided by the operator stepping from his seat to the control board and turning a key. The light indication on the board will show that the proper fan has been speeded up in response to the automatic call for more air, and the bright light indicating high CO will soon become dim again.

On a third board in the same room are installed reproductions of the traffic signals in the tunnels, each traffic light being represented by a miniature light on the board. Green lights show throughout the tunnel and on the board when everything is clear. If a block occurs at any point in the tunnel roadway, the nearest traffic officer will push a button setting the red signals against traffic from the block back to the toll booths at the entrance. This change of signals immediately shows on the traffic board in the supervisory room. The supervisory operator from the board in the control room displays stop engine signals in the part of the tunnel where the red traffic light appears.

In the supervisory control room are also located two telephone switchboards, one for the regular telephone service and one for the tunnel telephone system. If the stoppage in the tunnel roadway is such as to require towing by the emergency equipment, the traffic officer telephones to the supervisory operator, stating what equipment is needed and at what station. The supervisory operator transmits this message by Telautograph to the emergency stations and to the police desks at both exits. The supervisory operator next turns a key on the traffic board displaying a set of yellow lights throughout the entire length of the tunnel affected. When these lights appear, the traffic officers step from the sidewalk to the tunnel roadway and divert all traffic into the right-hand lane, leaving the left-hand lane clear for the emergency equipment to enter from the exit end of the tunnel against traffic. When the disabled vehicle is passing a designated station on its way out, the traffic officer at that station telephones the supervisory operator, who removes the yellow lights, restoring normal traffic conditions.

Ventilation—Prior to the opening of the tunnel, air-

measurement tests were made on seven of the blower ducts to determine the actual quantities of air supplied to the tunnel and the distribution of the air throughout the length of each duct. Time did not permit the completion of these tests on the remaining ducts. From the tests made, it was determined that the quantities of air supplied agreed very closely with the theoretical quantities. In general, the actual quantities were slightly above the theoretical quantities. No adjustment of ports was required, the original settings based on calculations and tests on models giving the uniform distribution desired.

Provision was also made for checking in the tunnel the experimental data obtained from tests on models forming the basis for the formulas used in calculating the ventilation system. This work is now being carried on under traffic conditions which necessarily interfere with the progress of the work. No definite conclusions can yet be drawn, as the work has not been completely analyzed. There are indications, however, that the formulas may have to be slightly modified to agree exactly with actual conditions in the tunnel.

Tests have also been made on the power required to operate the fans at full capacity as compared with that calculated in advance. On the blower fans the horsepower agreed closely with the calculated values. On the exhaust fans the actual figures were slightly higher than those calculated, due to greater losses, caused by turbulence, in the fan rooms, than had been anticipated.

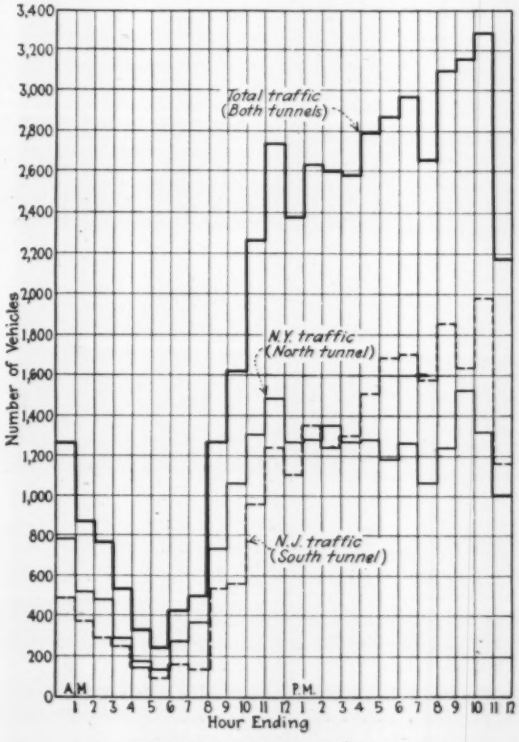
The real test of the ventilation system came on the opening day. There was no way in which the traffic could be forecast. The fact that it was a Sunday added to this uncertainty. Orders were given to operate the ventilation equipment at its normal maximum capacity, supplying about 3,760,000 cu.ft. of fresh air per minute. On that day nearly 52,000 vehicles passed through the tunnel, 98 per cent being passenger cars. During the first 24-hour period with this large volume of traffic, the average carbon monoxide content in both the south and north tunnel was 0.69 part per 10,000 parts of air. During the maximum hourly period in the south tunnel between 4 and 5 p.m., with a traffic of 2,371 vehicles, the average CO content was 1.60 parts per 10,000, and during the peak hour in the north tunnel between 5 and 6 p.m. it was 1.58 in 10,000 parts of air. The permissible standard as determined by the investigations was 4 parts CO in 10,000 parts of air. The ventilation system had thus been subjected to a sudden and rather severe test and met this test satisfactorily. With the opening day rush over and traffic settling down to more normal conditions, and in view of the extremely good air conditions in the tunnel on the first day, it was apparent that the ventilation could be reduced. This was gradually done by slowing down the fans and by shutting down some of them.

During the last six-month period of the first year of operation, with a total of 4,866,781 vehicles using the tunnel, the ventilation has been provided on the basis of the carbon monoxide not exceeding 2½ parts per 10,000 for a period of five minutes in any of the fourteen sections of the tunnel. The average carbon monoxide content during that period has been much below this figure. This has required the operation of one fan at half speed on each duct except during certain periods of the day where increased ventilation has been provided on certain sections either by running one fan at higher speed or two fans.

During this six-month period the electric power bill for all purposes, including ventilation, pumping, lighting of the tunnel, the plazas, the ventilation and administration buildings and for all miscellaneous purposes, has averaged $17,005.33 per month, or at the rate of $0.0211 per vehicle using the tunnel.

With one fan at half speed on each duct, the total quantity of air supplied is approximately 1,220,000 cu.ft. of fresh air per minute. On a typical busy Sunday afternoon during the summer and early fall, with the hourly traffic through the south tunnel averaging about 1,950 vehicles and through the north tunnel 1,550 vehicles, the air supply to both tunnels has been about 2,650,000 cu.ft. of fresh air per minute. It has been demonstrated that the maximum ventilation requirements have occurred at times when for some reason traffic is moving very slowly and the cars are tending to crowd close together. Under such conditions more air is required than when both lanes are operated close to capacity at the maximum allowable speed.

With this system of ventilation there is no longitudinal draft through the tunnel when there is no traffic in the tunnel, but with moving traffic there is a noticeable longitudinal draft in the direction of the traffic, the velocity of the air depending on the number of vehicles in the tunnel and the speed at which they are traveling. This longitudinal movement has reached a velocity of 10 m.p.h. when there is a mixed traffic of about 1,000 vehicles in one tunnel per hour. The result of this longitudinal movement with fresh air carried into the tunnel at the entrance portal is materially to reduce the carbon monoxide content in the half of the tunnel nearest the entrance, but it has little effect on the carbon monoxide in the other half of the tunnel. For this reason, as well as on account of the adverse grades, more fresh air is



TYPICAL SUNDAY TRAFFIC

N. Y. traffic (north tunnel), 22,706; N. J. traffic (south tunnel), 23,341; total, 46,047. The drop in traffic between 11 p.m. and midnight is not so great as indicated, because the count is taken before midnight due to changing shifts in the tunnel.

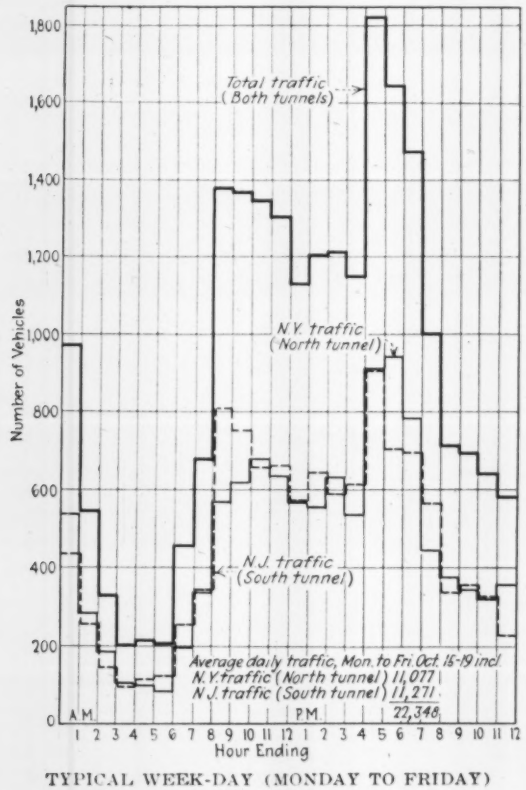
required to be supplied by the fans near the exit of the tunnel than near the entrance.

The draft is sufficient to be annoying to the policemen stationed in the tunnel in cold weather, and windshields are now being installed at the fixed posts to serve as a protection.

With ample facilities for providing a liberal degree of ventilation, the tunnel has not yet been operated on the basis of the standard which was originally adopted as allowable—namely, 4 parts of CO in 10,000 parts of air. It appears probable that the smoke from poorly conditioned automobile engines may become a limiting factor for comfort as soon as or sooner than the carbon monoxide.

On foggy days when the fog is so dense on the river that it seriously interferes with ferry traffic, the fog is also noticeable in the tunnel, but is not nearly so dense as on the outside, and at no time has there been sufficient fog or smoke in the tunnel to interfere with safe driving conditions.

Many persons who are occasional or regular users of the tunnel have stated that they find the air conditions in the tunnel better than on the city streets. This can be readily understood when it is borne in mind that investigators of carbon monoxide conditions on city streets have found the carbon monoxide present on



TYPICAL WEEK-DAY (MONDAY TO FRIDAY) TRAFFIC

The count between 11 p.m. and 1 a.m. in this chart is modified by the change of shifts before midnight.

open streets in amounts up to 1.7 parts in 10,000, and this gas and smoke is often present locally in objectionable concentrations on still days. In the tunnel, on the other hand, where the air is constantly in motion, the fresh air stream dilutes the exhaust gases immediately upon their being expelled from the engine, preventing any local concentrations.

Another factor which makes for the purity of the tunnel atmosphere is the fact that, for about half the length of the tunnel, the air is supplied through ventilation buildings located 1,000 ft. out in the river, with the air intakes at least 50 ft. above the water level, where the air is comparatively free from dust and other impurities usually present on city streets.

From a superficial examination of the operating experience, so far as the ventilation is concerned, the impression may be gained that, with the large reserve capacity of equipment, the tunnel is overequipped. This, however, is not the case, as it should be borne in mind that the tunnel is now operated to about half its capacity except on certain Sundays and holidays, and also that the percentage of passenger cars has been very large, the average being about 78 per cent. The ventilation system was designed on the basis of about 20 per cent passenger cars and about 80 per cent commercial vehicles. There has been a small but steady increase in the percentage of commercial vehicles with a corresponding decrease in the percentage of passenger cars, and it is expected that this change will continue and may some day approach or reach the ratios originally assumed. Commercial vehicles, especially the larger trucks, require a much larger volume of fresh air per minute per vehicle than do passenger cars, and when the tunnel is operated to its capacity, with a large percentage of the traffic commercial, the ventilation system will be put to its greatest test. It is expected that at such time the reserve capacity of the equipment will not be excessive but will provide only the comfortable margin which was had in mind in planning the ventilation system.

The tunnel police regulate the traffic in the tunnel, on the New York entrance plaza and on the plazas in Jersey City. The New York exit plaza is policed by New York City due to the impracticability of segregating the tunnel traffic from the heavy street traffic at this point. The tunnel roadways are policed generally by eight men on fixed posts in each tunnel. In addition there are two motorcycle policemen patrolling the tunnel and plazas. There are about as many policemen on duty on the plazas as in the tunnel, which makes it possible to rotate the men so that they do alternately two hours duty in the tunnel and two hours on the plazas. This arrangement has worked satisfactorily, and there has been no case of discomfort on the part of the police due to atmospheric conditions in the tunnel.

The fresh air supply ducts in the tunnel are cleaned every few months to prevent the fine dust carried in with the air and deposited in the ducts when the fans are operated at low speed from being carried into the tunnel roadway when the fans are speeded up. The best method of cleaning these ducts is by flushing with water.

The exhaust ducts have been cleaned at more frequent intervals, as some of the soot and dust from the roadway accumulates in them. The cleaning of these ducts is done by sweeping. The dust has been analyzed with a view to determining whether it could form explosive mixtures with air, and all samples analyzed have shown a safe margin in this respect.

The electric power for the operation of the tunnel is purchased from commercial companies on both sides of the river, about one-half being taken from each company. The current is supplied over three independent feeders from each company, each of the six cables having a capacity to carry the entire tunnel load.

During the twelve-month period there have been a total of 53 outings of feeders from one company, with a total elapsed time of 467 hours and 24 minutes. At no time

were more than one of the three feeders out at a time. Of these interruptions all but two were by request for maintenance and inspection purposes and were made at a time convenient to both parties. In the two other cases, one feeder was accidentally out for ten minutes and in the other case for a few seconds only.

In the case of the other company there have been a total of 32 outings, with a total elapsed time of 226 hours and 3 minutes. Of these interruptions all were prearranged except four. In one case one feeder was accidentally out for 44 minutes and on another occasion two feeders went out simultaneously. One of these feeders was out for four minutes, was restored and was lost again after five minutes, and was out the second time for ten minutes; the other feeder was out for twenty minutes.

In addition to these interruptions which originated with the power companies, one interruption of 2 hours and 23 minutes was caused on one feeder by a defect originating in the tunnel system.

The temperature in the tunnel has been more uniform than that outside. During the winter it was considerably higher than the temperature on the streets, and marked changes in the outside temperature were less noticeable in the tunnel. If a sudden change of 10 to 15 deg. F. occurred on the streets, a change of not more than 3 or 4 deg. occurred in the tunnel, and this lagged from two to four hours behind the outside change. The tunnel temperature during the summer averaged about the same as that outside, but, as in the winter, sudden changes were far less marked. During the winter months the tunnel temperature hardly reached the freezing point except near the portals, and during the summer did not exceed 83 deg. F. with a maximum outside temperature of 89 deg. on the same day.

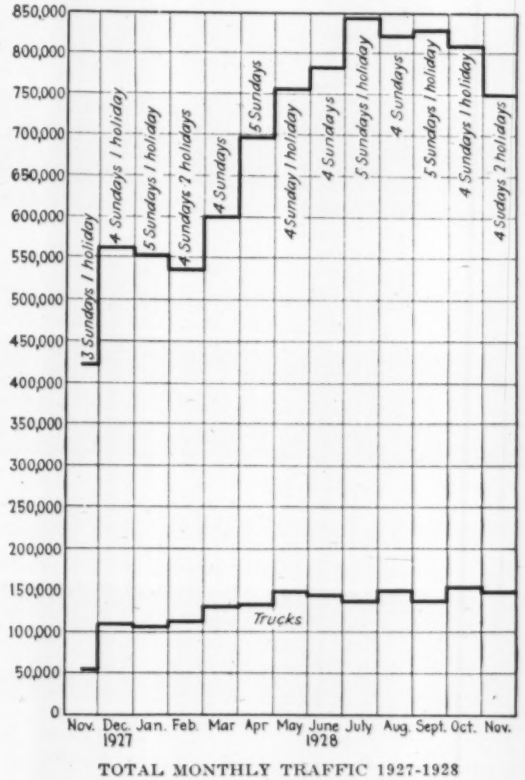
The tunnel has proved to be watertight, so much so that during the summer season there is hardly a trace of moisture coming through the tunnel structure. During cold weather, due to contraction, there are minor seepages at a few points. The only considerable leak which has developed is on the open approach outside the portal at the New Jersey entrance, where the movement in a contraction joint in the steel and concrete structure has been excessive, causing damage to the waterproofing.

Precise surveying has been carried on to determine the movement of the tunnel structure in the silt. At the time of opening the tunnel practically all movement due to disturbance of the silt during the period of construction had ceased. Very little vertical movement has been observed subsequent to the opening of the tunnel. The maximum settlement, 1 in., occurred between the New Jersey bulkhead and the river shaft at a time when dredging operations were carried on in the adjoining slips. The maximum settlement between the river shafts occurred at a point 600 ft. east of the New Jersey river shaft and amounted to ½ in. During the last six-month period no settlement has been detected.

The lateral movement has been greater, amounting to as much as 4 in. in a northerly direction of the south tube and 2½ in. in a southerly direction of the north tube. After having reached these figures the tubes have again come back to their original positions and have even slightly passed them. The maximum lateral movement has occurred at a point about 400 ft. east of the New Jersey river shaft, which is a fixed point, the shaft being supported on piles extending to rock. Vertical movements with the tide have been reported to have taken place in other Hudson River tunnels. No such movement has been detected with the use of precise surveying instruments on the Holland Tunnel.

The tunnel was built and is operated by the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission, and is owned jointly by the State of New York and the State of New Jersey.

Much popular interest has been shown in the experience of the commissions with respect to the financial return



TOTAL MONTHLY TRAFFIC 1927-1928

on the investment which the states made in this first vehicular tunnel. The total cost was approximately $48,400,000, not including interest during construction, each state paying one-half. The legislation in New York authorizing construction directed the commissions to fix a schedule of tolls that, in addition to paying the operating charges, would return the cost of the investment to the public treasury within twenty years. New Jersey's share of the cost was financed by a bond issue to be amortized from tolls. The profit from the operation of the tunnel over actual operating costs in the first year of operation was more than 3¼ million dollars, one-half of which was payable to each state. During the first year the tunnel has been operated to about one-half its estimated capacity. It is expected that there will be a steady increase in traffic through the tunnel until the capacity is reached about the year 1934. There will also be a gradual increase in the average toll per vehicle, due to the increase in the percentage of commercial vehicles, so that after 1934 the net income, after paying operating charges, will be more than $7,000,000 per year. It is thus apparent that financially there will be accomplished in a much shorter time what the legislatures, when the building of the tunnel was authorized, hoped and expected it would be able to accomplish within a twenty-year period.

Fig. 1—On the Road-to-the-Sea; El. 8,500 ft.

Building the "Road-to-the-Sea" in Colombia

Highway Crossing the Andes Being Built by American Contractors—Pack-Mule Transport and Hand Labor Make Subgrade for Hauling in Modern Roadmaking Machinery

By John H. Caton
Chief Engineer, R. W. Hebard Company, Inc., New York

THE construction of a trunk highway in the Republic of Colombia, South America, from Medellin, situated on a high interior plateau, across a wild mountain region to a port on the Caribbean Sea is an important project undertaken by the government of the Department of Antioquia for the primary purpose of eliminating the long delays and high costs involved in present methods of transportation. The progressive city of Medellin, capital of Antioquia, has a population of 100,000 and is the center of a commercial territory having more than 2,000,000 inhabitants and the principal product of which is coffee. At present all freight has to reach it over a long, difficult and uncertain route.

Cargoes are landed at Puerto Colombia, on the Caribbean Sea, and freight is carried 17 miles by rail to Barranquilla, on the Magdalena River, where it is passed through the customs and transferred to river steamers. Here troubles begin, for even if the transfer is made promptly, there is the likelihood of loss and damage due to lightly built shallow-draft vessels and a dangerous river which is swift and shallow, has a shifting channel and is full of sandbars and snags. Its vagaries are unknown even to the experienced pilots. In the dry seasons, usually two periods of about three months in each year, the river becomes more or less unnavigable for cargo steamers. In the periodical dry years, said to be each six years, the river is almost completely out of service for as much as nine months at a stretch. In consequence this is a period of virtual paralyzation of transport and commerce throughout the greater part of the country.

The river trip is 503 miles to Puerto Berrio, where freight is transferred to the Antioquia Railway for the 122-mile trip to Medellin. This railway is not continuous, in that freight has to be transfered to trucks for a road across the summit and then again transferred to the railroad. A tunnel 3.5 km. (2.17 miles) long is now being driven for a line to connect the two sections of the railroad (see *Engineering News-Record*, Oct. 15, 1925, p. 620).

Experience with this 642-mile route from the coast by the contractor for the new highway indicates that it takes usually from five to six months for freight to travel from New York to Medellin, three-fourths of which time is accounted for after delivery at Puerto Colombia. The freight cost is always high and runs to fantastic figures when the river is low.

To overcome the great economic loss due to high cost and the slow and interrupted freight movements, Antioquia has faced the problem of creating a better and dependable route to the coast and is building what is called the "Carretera al Mar" or Road-to-the-Sea. It is a highway instead of a railroad for numerous reasons, but principally on account of the extremely difficult mountainous country encountered. The distance will be approximately 255 miles, and the trip is estimated at twelve hours for passenger cars and 25 hours for freight trucks. The through freight to be handled when the river is low

is approximately 700 tons daily, about equally divided in each direction. The character of the country is indicated by the views, Figs. 1 and 2; a plan and profile are given in Figs. 3 and 4.

From the profile it will be seen that the route crosses two towering ranges of the Andes, the Cordillera Central and the Cordillera Occidental. Starting from Medellin at El. 4,916 ft. above sea level, the first summit is crossed at El. 8,361 and the second at El. 7,065, after having dropped to El. 1,689 in the intervening valley of the Cauca River. From the second summit the profile falls rapidly into the Atrato River valley and thence eases down to the sea. The country traversed represents all climates. From cool temperatures down to 46 deg. F., where white clover, buttercups and blackberries grow much the same as in New England, it ranges to the hot tropical jungle of the south Carribbean coast, where wild animals abound in an almost uninhabited virgin forest country. The forest is a typical tropical mixed stand, containing some cedar and construction timbers.

For the first 60 miles from Medellin the country, despite its extraordinary slopes, is well populated and cultivated. The higher, rougher country is largely pasture. From this it ranges down through a coffee-raising belt to the tropical fruit and grazing country of the Cauca River valley. In the high country, the stone walls on boundary lines again remind one of New England; except that here the slopes are so steep that the walls seem to be for the purpose of keeping the grazing animals from falling out of the lot.

For the next 24 miles the road works up a deep, narrow gorge in badly broken country to the second summit. The upper slopes above this gorge are well populated and cultivated. At the second summit the line breaks into a narrow and wonderfully rich valley which has been well developed within recent years and which has the progressive towns of Canasgordas and Frontino. As the elevation decreases, the road again passes through a coffee-raising belt into sugar and cotton lands. The price of cotton in the United States affects the price paid here.

At Dabeiba all intensive development ends and the location is in rough canyon country—wild, forested and having an excessive rainfall. This extends for some 33 miles, when the valley floor is reached and the canyons disappear. At the beginning of this stretch the white settlers cease and the country thence to the sea is principally inhabited by a half-wild tribe of Indians, with negroes at little towns at the head of navigation for canoes on the branch rivers, where ivory nuts are found and exported.

FIG. 2—ROAD GRADING IN THE ANDES

The proposed seaport is at Necocli, on the Gulf of Uraba (or Darien), where ample depth of water is available close to shore. Geologically the line in mountainous country is through disintegrated igneous rocks in which there are numerous showings of blue granite minus the mica content. The rock is badly shattered by earth movements. The soils are red, blue and gray clays covered with a thin vegetable cap. North of the second summit are disintegrated shales which are marvelous for their angle of slope, often up to 60 deg. Limestones, carboniferous and conglomerate rock appear at Dabeiba; the valley floor farther along is a hard river gravel overlain with 2 to 3 ft. of vegetable loam.

For the road itself, the standard section is shown in

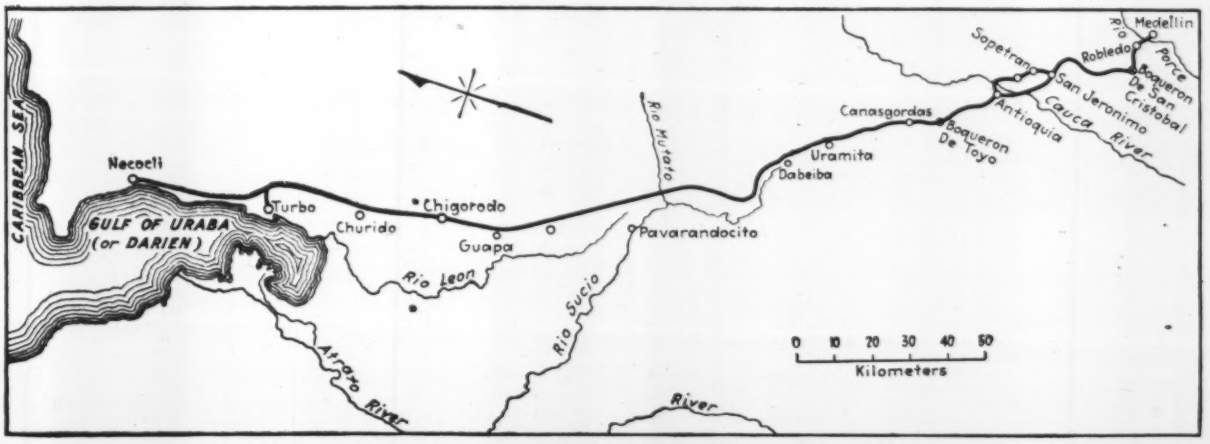


FIG. 3—TRANSANDINE HIGHWAY IN COLOMBIA, SOUTH AMERICA

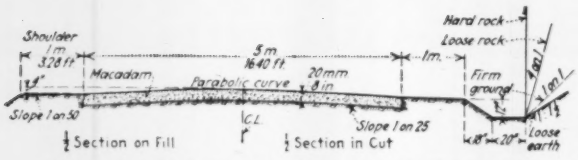


FIG. 5—TYPICAL CROSS-SECTION OF PAVED ROAD

Fig. 5. The design of a highway through this exceedingly difficult country that would meet the traffic requirements and still remain within reasonable cost was the subject of much study by various local engineers. The general engineering specifications are as follows: Right-of-way, minimum 20 m. (65.6 ft.); width of road, 7 m. (22.5 ft.); surfaced width, 5 m. (16.4 ft.); maximum grade, 5 per cent without compensation on curves, this low figure being adopted on account of loss of power in internal-combustion engines at the high altitudes; minimum grade, in cuts, 0.5 per cent.

For curves, the minimum radius is 114.74 m. (376.3 ft.) in open country and 38.64 m. (126.7 ft.) in mountainous country, with a sight distance of 60 m. (197 ft.). Consecutive curves in the same direction may be compounded or else separated by minimum tangents of 50 m. (164 ft.). Curves in opposite direction are to have intervening tangents with a minimum length of 15 m. (49.3 ft.). All curves between the above radii are widened on the inside by spiraling. All curves between 38.64 and 250 m. radius (126.7 and 820 ft.) are superelevated. All other curves, of which there is none in the first 120 miles, are to be simple circular curves without widening or change in standard crown.

Bridges have a clear width of 6 m. (19.7 ft.) except for temporary structures, and a headroom of 4 m. (13.12 ft.) in steel or covered spans. They are designed for a load of two 15-ton trucks operating in opposite directions. On account of transportation difficulties, construction standards call for dry-laid masonry as far as possible. For the same reason, culverts up to 6 ft. in diameter are of corrugated galvanized-iron pipe, and these are sometimes used in batteries. Some local brick walls and some mortar-laid walls have been used for both retaining walls and for culvert end walls. The surfacing calls for a two-course standard waterbound macadam of 8-in. compacted thickness; to be followed, after the road has reached the sea, by a bituminous macadam course with a compacted thickness of 2 in. Guard rails, cautionary signs, kilometer posts and other accessories are to follow standard practice.

Construction work was begun by the contractors on Feb. 21, 1927, at the first summit, 20 km. (12.4 miles) from the nearest town. The first 20 km. from Robledo,

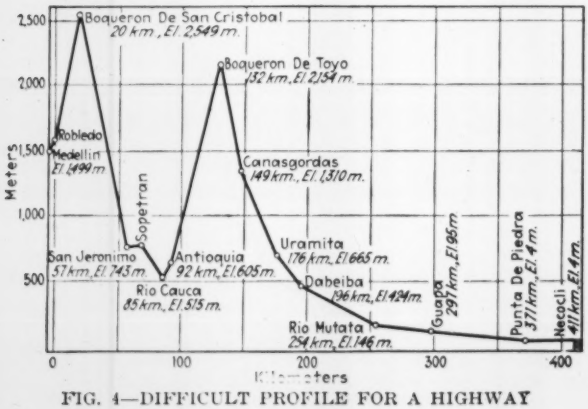


FIG. 4—DIFFICULT PROFILE FOR A HIGHWAY

at the Medellin end of the work, had previously been undertaken by government administration force account and was partly completed.

Pack mules were the only means of transportation and they had to climb 3,500 ft. in approximately 8 miles to get to the work. A standard load for a pack mule is 200 lb. Special loading is by means of using mules in tandem, if the trail permits. Transport of motor trucks to the work by pack mules is shown in Fig. 6.

On this account and due to the excellence and cheapness of local labor, practically all earth and rock movement has been done by hand methods and the faithful shovel, pick, wheelbarrow and other numerous well-known hand tools, together with portable or industrial railway track, have accounted for the progress made. As soon as subgrade permitted, tractors and their trucks have followed, bringing in concrete mixers, compressors, hoists, crushers, rollers and other equipment; so that

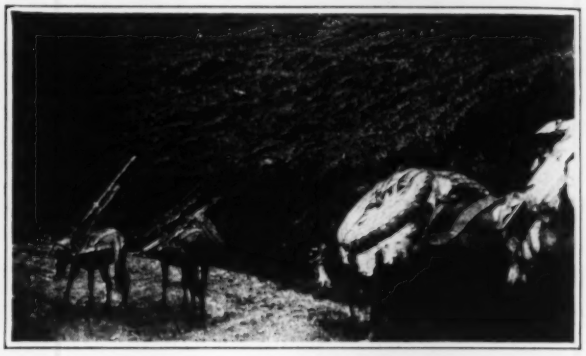


FIG. 6—MULE TRANSPORT FOR A MOTOR TRUCK

bridge building and surfacing operations closely follow similar operations elsewhere.

A summary of work done during the first sixteen months of contract construction shows the power of the lowly hand tool when used in considerable numbers: Earthwork, 2,625,160 cu.yd.; rock work, 1,264,760 cu.yd.; retaining walls, 42,226 cu.yd. Other and additional handwork done during this time has been the construction of 44 miles of tractor road through a wild forested country; 61 miles of pack trails; 11,628 cu.yd. of bridge masonry; 62 miles of drainage ditches outside of the limits of the standard cross-section, and the installation of a large number of corrugated galvanized-iron culverts. A combination of machine and hand work has put down a total of 14½ miles of surfacing. All labor has been recruited locally and has several times reached a peak of 6,000 men.

Funds for the Highway-to-the-Sea have been furnished by a series of 7 per cent Department of Antioquia loans, sold to American bankers, plus a subvention received from the national government. The firm of R. W. Hebard & Company, Inc., New York, has the general contract for the Medellin-Dabeiba division, 200 km. (124 miles), and during the past year it has conducted location surveys for the section from Dabeiba to the proposed port of Necocli. The engineering and construction staff has been composed principally of Colombians and Americans, with the former predominating. John H. Caton is chief engineer for the contractors, and Dr. Eduardo Orozco, of Medellin, is chief engineer for the Highway-to-the-Sea Commission, the president of which is Gen. Pedro J. Berrio, Governor of the Department of Antioquia.

Springbank Recreation Dam at London, Ont.

Pool 4 Miles Long Will Be Lowered at Summer Floods by Removing Stop-Logs and Emptied in Winter

A DAM to provide a long stretch of boating and other recreation facilities is being built across the Thames River by the city of London, Ont. It is unusual in that the 4-mile pool formed by it will be drawn off entirely in winter and drawn down as may be needed at times of summer floods, which are highest after heavy July rains. In summer the drawoff will be effected by removing stop-logs. Before winter sets in, besides removing the stop-logs, the steel columns into which the logs fit will be swung upward through a 90-deg. arc, pivoting on their upper end and the columns slung in a horizontal position close beneath the deck of the dam. These drawoffs are precautionary measures against flooding a portion of the city that was inundated at very high water years ago. The complete opening of the dam between piers in winter takes into account both flooding and possible trouble from ice in the pool.

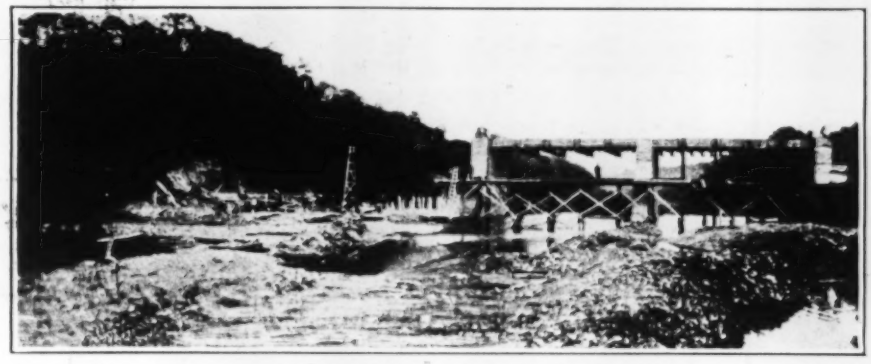
The main dam is 225 ft. long with flanks running up the banks. The dam raises the water 20 ft. at the dam and 2 ft. some 4 miles upstream, in the city. Opposite Springbank Park the full water level will be about on the contour line of the park walk nearest the river, whereas now the river is below and at some distance.

Except for the steel columns which hold the stop-logs and the steel girders that carry the deck, the dam is of reinforced concrete. Five piers, including one at each end, divide the main dam into four 50-ft. bays. Each of these is in five subdivisions formed by the vertical steel stop-log columns, which are held in position by counter-bases. The stop-logs are 10x12-in. British Columbia fir. An electrically operated crane running on a track in the deck lifts out the stop-logs, for stacking on the deck. The same crane is used to swing up the steel columns for suspension under the deck in winter.

The structure is supported by a reinforced-concrete mat, with cutoff walls 5 and 10 ft. deep. The natural supporting material is a dense, hard clay that had to be blasted in some places.

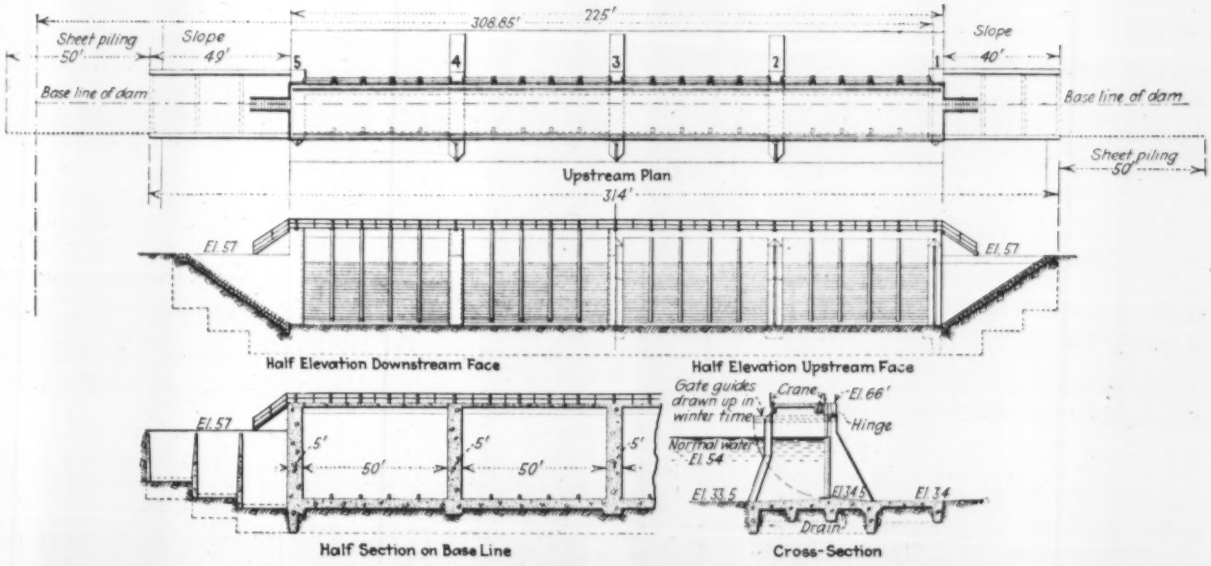
Construction was begun in June, 1928. On Nov. 1, 1928, about three-fourths of the mat was in place, three of the five piers had been poured together with the deck, some steel columns had been hung and work had begun on the remainder of the mat. It is expected that the dam will be in use in the summer of 1929.

On some of the bays the steel columns already mentioned have been suspended crosswise of the dam, beneath and supported by the longitudinal steel girders, to hold the bottom forms of the deck slabs while being poured.



SPRINGBANK RECREATION DAM

The city voted $150,000 for the dam and supplementary work, to be expended by the London Utilities Commission, an elected body of four, with the Mayor as chairman ex-officio. This commission operates the water-works, the electric distribution system and the parks



PLAN AND SECTIONS OF SPRINGBANK RECREATION DAM, LONDON, ONT.

and playgrounds of the city. The dam was designed by H. G. Acres & Company, consulting engineers, Niagara Falls, Ont. The work is being done by contract, the dewatering and concrete by J. A. Vance, Woodstock, Ont.; the steelwork by the Sarnia Bridge Company, Sarnia, Ont. Construction is supervised by W. P. Near, city engineer, under the immediate charge of J. R. Rostron, assistant engineer to the city on structural work.

Cement Gun Enlarges Column Sections for Additional Load

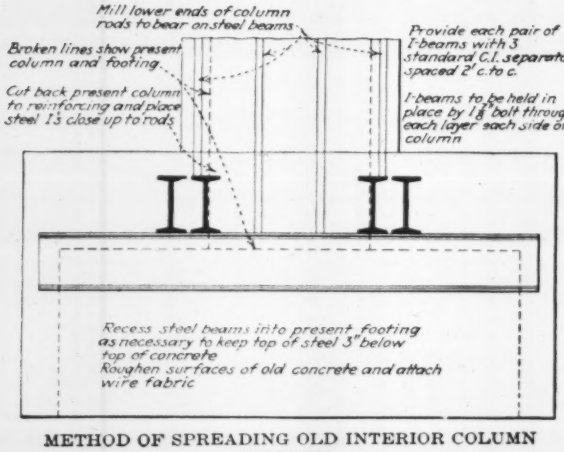
Four Stories Added to Concrete Frame Garage by Spreading the Footings and Guniting the Old Columns

By A. D. Hilborn
Miami, Fla.

IN THE spring of 1925 a rapidly increasing business made it necessary to build an addition to the Burdine department store in Miami, Fla. The element of time was important; the additional space was urgently needed for the opening of the winter season.

Adjacent to the main store building was a two-story garage owned by the Burdine Corporation. The frame of the garage was of reinforced concrete designed for the existing height of two stories. Because considerable time could be saved and the cost would be less than would be incurred were the present structure removed, it was decided to strengthen the columns and footings sufficiently to permit of carrying the annex up to six stories in height, making the addition the same height as the main building.

Several methods of procedure were considered before the final plan was adopted. The column spacing was greater than was necessary for a store occupancy and it was unsymmetrical. This fact led to a suggestion that additional columns might obviate the necessity for strengthening the present members. It was found that while this would solve the problem in one portion of the building it was not practicable in another. The use of structural-steel reinforcing for both columns and footings was given some study, as was also the use of the cement gun. A combination of structural steel and the cement gun was finally settled upon.


Mill lower ends of column rods to bear on steel beams
Broken lines show present column and footing
Cut back present column to reinforcing and place steel 15 close up to rods
Provide each pair of I-beams with 3 standard C.I. separators spaced 2' c. to c.
I-beams to be held in place by 1" bolt through each layer each side of column
Recess steel beams into present footing as necessary to keep top of steel 3" below top of concrete
Roughen surfaces of old concrete and attach wire fabric

METHOD OF SPREADING OLD INTERIOR COLUMN FOOTING

The footings rest on native rock interspersed with sand pockets. It was found that the tops of the footings could be raised 1 ft. The necessary increase in spread could be made and an additional 12 in. in depth secured satisfactorily and economically by the use of the cement gun. The high compressive strength of the gunite would have satisfied the requirements in both flexure and shear, but the additional 12 in. did not afford a sufficient depth to steel to take care of either bond or tension due to bending. It was accordingly decided to reinforce the footings by means of steel beams. This scheme offered the additional advantage that the footings could be strengthened while waiting for the cement gun and crew.

In enlarging the footings provision was made for bond

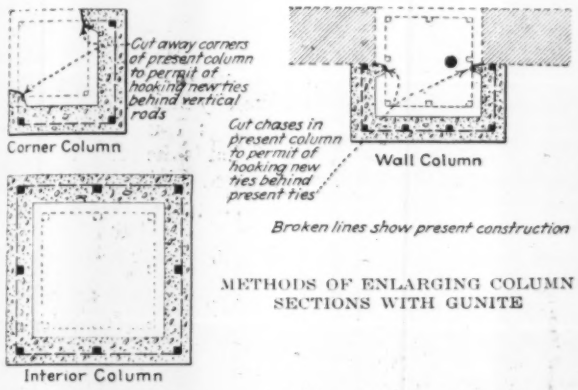
OLD COLUMN PREPARED FOR GUNITING
Note the reinforcement in place and the shooting strips erected to guide the placing of the gunite.

by roughening the old surface and coating it with a thick grout just prior to concreting. It seemed unwise to assume that a perfect bond could be secured or that it would be justifiable to consider the effective depth to reinforcing as the distance from the new top of footing to the center of the steel even in case a mechanical bond were provided. The required sections of steel beams were determined by deducting from the bending moments of the new footings the resisting moments of the old footings and providing structural I-beams to supply the difference. No hesitation would have been felt in assuming a fully effective bond had the cement gun been used in building up the footings. The footings were difficult to reach effectively with the cement gun and the excess cost of gunite over poured concrete would have exceeded any saving that could have been effected in steel.

A direct transfer of the load from the column to the reinforced footing was assured by chipping away sufficient concrete from the columns to permit of clamping the steel I-beams tight up against the vertical reinforcing rods. When the column section was later restored and enlarged with the cement gun, a substantial shoulder was provided, bearing directly over the steel beams.

There were 73 columns that required reinforcing. A large number of these were wall columns on the property

line. Even though sufficient concrete block spandrel wall were removed to permit of working close up to the building line, it would still be impossible completely to incase the old columns. If the cement gun were used, it would be possible to build on the exposed surfaces of the old columns without disturbing the spandrel wall. By uncovering reinforcing steel sufficiently to permit of hooking the new column ties behind either vertical rods or ties in the existing construction a firm connection could be assured. The use of the cement gun would make it possible to build up the new work to a solid bearing under the beams, which was important. This plan was adopted and the typical columns were detailed as shown in the sections. Column ties ¼ in. round were


Cut away corners of present column to permit of hooking new ties behind vertical rods
Corner Column
Cut chases in present column to permit of hooking new ties behind present ties
Wall Column
Broken lines show present construction
Interior Column

METHODS OF ENLARGING COLUMN SECTIONS WITH GUNITE

placed on 6-in. centers, a fairly close spacing being a help in supporting the gunite during construction.

In designing the additions to the columns the carrying capacity of the old column, making allowance for the increased section that could be regarded as core, was figured on the basis of 450 lb. per sq.in. on the concrete with n taken as 15. A sufficient section of reinforced gunite was added to carry the remaining load at a maximum stress on the gunite of 900 lb. per sq.in. with n taken as 10. A minimum of 2½ in. of gunite was regarded as necessary, as the reinforcing could not be satisfactorily protected with a less thickness. This requirement resulted in most cases in a gunite stress considerably less than the maximum. The gunite sections varied in thickness from the minimum of 2½ in. to a maximum of 11 in. on one face of one of the wall columns.

The necessity of shooting the gunite onto the concrete surfaces at approximately right angles in order to secure the best results made it difficult to use any forms, and yet it was necessary to finish the columns to a reasonably true surface. This was accomplished by placing guide or screed strips at the two adjacent corners of the face under construction and building out, with the cement gun, to a slight fulness beyond the finished surface. The surplus was removed by working quite close behind the gun with a steel straight-edge.

The thickness to which it is practicable to build gunite on a vertical surface without sagging depends to some extent on the support offered by the reinforcing. It proved to be feasible in this case to place a 3-in. course at one continuous operation by working back and forth over the surface to be covered. In the case of columns requiring much, if any, more than a 3-in. reinforcement it was found advisable to move the operator to another column after placing from 2½ to 3 in. of gunite. The work would then be continued after the material already placed had set up sufficiently to eliminate all danger of sag.

Construction work in southeastern Florida was laboring under the handicap of a freight embargo at the time this work was under way. The supply of common laborers as well as of skilled mechanics was insufficient for requirements and heavy bonuses were being paid. This, together with the fact that the work was handled on the basis of actual cost plus a percentage, makes it impossible to say, from available figures, what the entire job, or the cement gun work alone, should have cost. A bid of $10,000 to cover the cement gun work only was submitted before definite arrangement for that part of the contract was made. This figure was considered excessive and was not accepted. The plans call for a total of 1,135 cu.ft. of 1:3 gunite.

Henry La Pointe was the architect in charge of plans and supervision. The general contract was let to the Herndon Construction Company. The gunite was placed by the Cement Gun Construction Company on the basis of a fixed daily rental for the equipment and a daily charge for the crew operating the machine. The writer was retained by the architect to prepare the structural drawings and specifications and to supervise the construction.

50-Ft. Concrete Bridge Piles Driven Six Days After Pouring

Illinois State Highway Department Uses High Early-Strength Concrete to Prevent Delay on Illinois River Bridge

By H. G. Farmer
Manager, Service Bureau, Universal Portland Cement Company

PRECAST concrete piles, 50 ft. long, of concrete with an average three-day compressive strength of 3,765 lb. per sq.in., made with standard portland cement, were used this year by the Illinois State Highway Department for a bridge over the Illinois River at Florence. In three days the piles were ready to be driven 35 ft. into the ground. A cross-section of the type of structure is shown in Fig. 1, and Fig. 2 shows the piledriver and some of the piles.

The piles were 14x14 in. x 50 ft. long, including a 5-ft. taper on one end, from 14x14 in. to 8x8 in. Corners were beveled by means of a 1½-in. V-strip in each corner of the form. Reinforcement consisted of four 1-in.

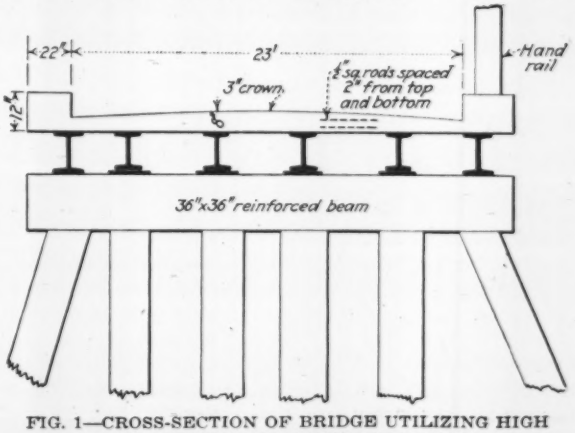


FIG. 1—CROSS-SECTION OF BRIDGE UTILIZING HIGH EARLY-STRENGTH CONCRETE PILES

round corrugated bars in the corners 2 in. from the face of the concrete. These longitudinal bars were wrapped with a square spiral of ¼-in. round wire pitched at 4 in. average in the main portions of the pile and at 2 in. in the 5-ft. tapered end.

Aiming at 3,500-lb. concrete in three days, a 1:1½:2 mix based on dry materials was used consisting of one sack of cement, 1½ cu.ft. of sand, 2 cu.ft. of stone and 3.75 gal. of water. A portable gasoline-driven two-sack mixer was used. A mixing time of five minutes gave a stiff and dense but workable concrete which spaded readily around the reinforcing. While concreting was in progress the air temperature ranged from 60 to 65

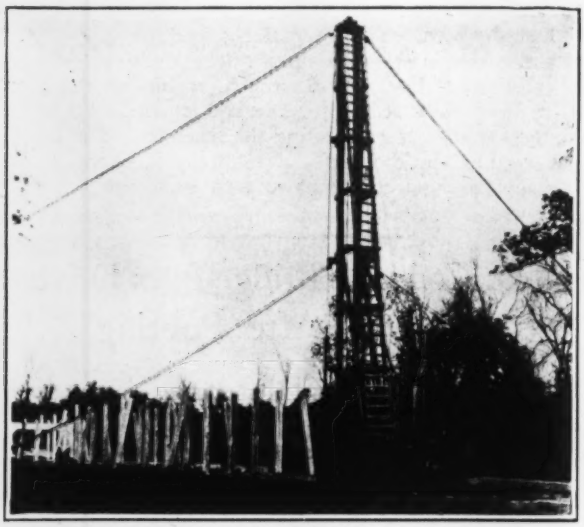


FIG. 2—DRIVING 50 FT. CONCRETE PILES OF HIGH EARLY-STRENGTH CONCRETE

deg. F. As a curing measure the piles were covered with sand, which was kept moist until the end of the three-day period. About four hours was required to make two piles.

Tests—At three days test cylinders cured under field conditions were broken under the 200,000-lb. testing machine in the state highway testing laboratory at Springfield. The average slump on test cylinders from four different piles was about 2 in. The highest test showed 4,482 lb. per sq.in. at three days. The average for the four piles was 3,765 lb. The load-carrying capacity of the individual piles, based on the weight of the hammer, the distance of the fall and the degree of penetration, was 58 tons each, or more than twice the load (27 tons) specified on the state plans.

Although the state highway authorities were satisfied that the strengths shown at three days were sufficient to warrant driving the piles immediately, they were not driven until three days later, when a piledriver became available.

Driving—The piledriver used a 5,000-lb. steam hammer with a fall of 3½ ft. With a pile hoisted into a vertical position by a rope wound around it at about the third point, it was driven to a penetration of 35 ft. In the earlier stages of driving, when the pile was nearly all out of the ground, it was subjected to severe bending stresses, but without damage. An examination of the pile after it was in place showed no cracking or chipping. The outer piles, as shown in Fig. 2, were driven on a batter.

A Layman Visits the Sewage-Works

Lack of Odors, Attractive Appearance, Cleanliness of Plant and Clarity of Effluent Agreeable Surprises

By Charles MacCabe Smith

Advertising Manager, Celite Products Company, Los Angeles, Calif.

I AM a layman. Most things I take for granted. When I open a faucet in my home I expect water to come forth. If it should fail, I should be greatly surprised—even if it hadn't rained on this watershed for two years. Why shouldn't I? Faucets installed in my house are made to bring me water. I pay my water bills the tenth of every month. It's not my worry if there isn't any water to pump into the city mains.

When I am through with things I usually consign them to the sewer. Good-by. What is the sewer? Why it's a system of iron and vitrified piping that starts in one's bathroom and goes—well, it goes down the street. I don't care where it goes, so long as it doesn't go into the ocean. I usually swallow some water when I am swimming and I shouldn't like to think I was swallowing sewage. I'd rather it didn't go into the river either. For I have to drive alongside the river on my way to the office, and I want to enjoy the fresh air.

What's the matter with sending it out to one of those sewage-disposal places? What are they? They're what we got for the two million dollar bond issue we couldn't vote down last year.

Two million dollars! Wow! Come to think of it, that's umpty dollars per resident. Must be something worth looking into.

Tomorrow I'll go out and see what it's all about. I'll wear that old suit I was going to give to the Good-Will Mission. Must be an awful place. Hope I don't come away with boils all over my arms. Chubby promises to take me out. He is our technical department.

* * *

We drive up between a vegetable garden and a beautiful flower plot.

My word! I never saw water used so lavishly in all of southern California. Chubby tells me that's the effluent. I am to find out later what he means. In the meantime I pick a beautiful posy and test its fragrance. We cross a broad expanse of perfect lawn to what looks like an administration building. In my mind I congratulate them, whoever that vague "they" might be, for locating their office far enough away from the plant to be away from the smell. "Mr. Smiley, meet Mr. Smith, our advertising man." Surely we may take pictures! Mr. Smiley is a genial good scout. If one hadn't been told differently, one would think he was a human being instead of an engineer.

Chubby leads. Right next door is the power plant. Four or five synchronous—I mean slender—motors are direct-connected to blowers. They use blowers altogether instead of compressors, I am told.

Outside the blower building we climb onto a concrete thing that looks like a rectangular reservoir. It is not, however, I presently discover, for right at my feet is a

rushing, turbulent stream of muddy water. On the other side of the stream are dozens of tanks formed by concrete partitions, some seething like the stream at my feet, others quiet and placid.

"What the devil has all this got to do with the sewage-disposal plant," I ask Chubby.

"This is the sewage-disposal plant," he replies.

I blow my nose to see what's the matter and look at him with that sneerful, doubting expression they all dislike.

"Sure it is," he replies; "the only place that ever really smells bad is the screening plant."

I had set my nose for a big smell. I'm a stubborn individual and am determined to get that smell, no matter how uncomfortable it might make me.

"All right, we are going to see the screening plant," Lo and behold, what an eyeful! All the things we laymen think go out of sight when we send them into the sewer are captured here, on a revolving, perforated drum that looks like the sorting screen in a rock-crushing plant. Spread before us in a deep tray are banana skins, earrings, apple cores. "Goodness, gracious me, let's go back to the sludge plant."

We detour, however, down to a building that houses three big Oliver filters and a couple of vacuum pumps. There is a little working model of an Oliver on a bench and Chubby pulls his hands out of his pockets and explains—I should say tells me—how the thing works. It's divided on the inside into three segments. Sludge comes in around the outside of a huge, revolving, cloth-covered drum, submerging about a third of it. A vacuum pulls the water through and the solids remain on the surface of the cloth, forming what is called a filter cake, about ¼ in. thick. In segment 2, more vacuum is applied to pull as much moisture as possible out of the filter cake. But when the cake gets revolved around to segment 3, the action is reversed and air pressure tends to separate the cake from the cloth. A little farther along a steel blade skims the cake off the drum. Here the cake resembles rotten sections of gray blanket as it tears off under its own weight and drops onto a conveyor belt that hustles it away beneath the floor.

The cake comes to view again in an adjoining building, where a train of steel disks slices it into small chunks just before it drops into the receiving end of a drier that looks every bit like a rotary cement kiln and fully as hot. A slight odor arises around the drier, as if the smelly bacteria were feebly revolting against a fiery extermination.

At the delivery end of the drier the stuff looks like sweet pea seeds. Innocent bags of it are piled high in the warehouse and I learn that truck gardeners and golf clubs are eager to pay fat prices for it, for they can't buy better fertilizer.

What a shame to think of all the valuable fertilizer that American cities are sending down the Mississippi, the Hudson and the Delaware! If their engineers could only be along with us today! But this is a quite typical sludge plant, Chubby tells me. The principal innovation is the disposal of the sludge. They filter it here instead of running it off into lagoons as they do in lots of places.

My mind is wandering back to my first sight of the plant.

"What about the effluent?" I ask.

We climb back onto the tanks and he points out the quiet pools on the east side.

"That's it, running off the top. It's chlorinated to less than 50 bacteria per cubic centimeter, a lower count than is often required of city water. Then it is used for irrigating these farms around here. Theoretically it is practically free of solids. But some of the stuff that is full of gas persistently floats on top and goes off with it. Some day we hope to perfect a means for filtering this effluent, too."

I am thinking now about the bacteria that have to be poisoned, and make my thoughts known.

"We have experimented with liquids containing 200,000 bacteria per cubic centimeter," Chubby continues, "and have brought the count down to 70 or 100 by filtering through filter-aid."

I cogitate strenuously and almost slip into an aeration tank as a penalty for paying too little attention to my feet. Millions of floc wave a ready welcome, almost a challenge that said I would not be able to swim in the stuff. No, I shan't try to show them. When it comes to a challenge to see if I can keep my head up, I'll try first among the engineers.

What can't one learn when one gets off the beaten trail!

Haul Bricks in Container Cars

Advantage in transporting brick by rail in container cars instead of in bulk on barges were noted in a paper on handling traffic with the container system, read by G. H. Wilson, superintendent, New York Central Railroad, at the recent annual meeting of the American Association of Railroad Superintendents. This part of the paper was substantially as follows:

The brick container car, with twelve containers, quickly came to the front as a very economical method of handling that commodity. These cars are also assigned to the crushed stone, sand and gravel trade. There are more than 20 large and several small brick yards along the Hudson River, between New York and Albany, that heretofore shipped about 90 per cent of their brick in barges to the New York market, involving manual handling from yards to barges, thence to docks and from docks to trucks for delivery at building operations. All these yards have in the past five or six years greatly increased their output and the container cars now handle about 90 per cent of it.

The brick yards have private sidings on which the containers are loaded with mechanical conveyors, and the container cars move in regular trains every night for the next day's delivery. At destination, the cars are placed on tracks spanned by electric traveling cranes (generally of 10-ton capacity) which pick up the containers and empty the brick into dump trucks. Each container has a capacity for 3,000 bricks and each car holds 12 containers, or a total of 36,000 bricks per car. It requires less than two minutes from the time the crane starts to hook on until the empty container is back on the car. At one station there are three parallel tracks with a total capacity of 38 cars, served by two cranes, and 76 cars per day are handled, or 2,736,000 bricks.

There are six such delivery stations at convenient locations in Greater New York and others are being established in suburban territory. The empty cars are returned every night by designated trains to their proper stations, where they are again loaded. The breakage of brick is fully 30 per cent less than by the old method of many manual handlings. While the rail rates are fair to the roads, the shippers get the brick to the consumer at less cost than by the old cumbersome method.

Asphalt Road Construction and Service Problems

Extracts From Outstanding Papers Presented at the Asphalt Paving Conference in New Orleans Give Cross-Section of Practical Problems Concerning Asphalt Road Builders

STABILIZATION of asphalt mixtures, asphalt road service records and improvement in construction methods are the practical problems which are concerning asphalt road builders. Methods of construction that will produce a smooth surface, an asphaltic mixture that will stay put and a maintenance cost record that will bear inspection are being sought. The papers abstracted here are selected from a score presented at the New Orleans conference on asphalt paving practices as presenting a fair example of the results of investigation and experience.

Time Losses in Asphalt Paving

By T. Warren Allen

Chief, Division of Management, Bureau of Public Roads, Washington, D. C.

DURING the past summer we have kept rather complete records on a number of jobs of the various causes which interfere with production. Tables I and II are summaries of the time losses on two typical jobs. The first job is fairly typical of the smaller plant and had a mixer capable of handling only a 750-lb. batch. The hauling equipment was good and the plant and other equipment could be classed as fair. The record covers a period of 793 available working hours, of which the job was actually working only 398 hours. A total of 395 hours, or practically one-half of this available time, was thus spent in enforced idleness.

The largest loss was, of course, due to the weather, which in this case included a rather unusually rainy period; 252 hours, or 31.8 per cent of the available time, was lost due to rain, wet subgrade and kindred causes. During the greater part of this time the payroll expenses of a crew of 68 men were limited to four or five straight-time men, including the superintendent, time clerk, one foreman and a night watchman. Moving the plant to a new siding consumed 71 hours, while plant breakdowns, mechanical troubles and changing from one mix to the other consumed an additional 43 hours, and a variety of miscellaneous causes consumed the remaining 29 hours. Practically one-half of the best portion of the contractor's working season was thus irretrievably lost so far as possible profitable operation was concerned.

But this was not the end of the contractor's time losses. More than one-fourth of the time, or 25.4 per cent of the total time he was actually on the job with his full crew, was lost in minor interruptions and delays. Thus a total of 10.5 per cent of the time he was out on the job was lost in waiting for hot materials; 6 per cent was lost because of minor mechanical troubles, chiefly at the plant; 4.5 per cent was lost because of inadequate truck supply; the mixer operator added 2.1 per cent to the contractor's already sufficient burden, while 2.3 per cent of the time was lost due to various miscellaneous causes. The operating cost of this job was approximately $350 per day. Consequently a loss of an average of 25.4 per cent of the working time represented a shrinkage in the contractor's possible profits of more than $80 per day. Not all of these minor time losses can be eliminated, but we have yet to find a job with large time losses of this nature, or, in other words, operating at a low rate of efficiency, on which it has not been possible materially to reduce the time losses, increase the rate of production and decrease the unit costs.

Another job which can be considered as typical of large plants during the best part of the construction season shows a total loss of only three hours in actual stops of any considerable duration. This particular study covered a period of only three weeks during the dry weather or the month of August, consequently no time was lost due to rain or wet subgrade. The total available time was 136 hours, of which the crew was on the job all the time and of which the plant was shut down only a total of three hours in stops longer than fifteen minutes in duration. Thus on this job during the time of the study less than 2¼ per cent of the total available working time was lost in stops of appreciable duration. A really enviable record!

TABLE I—TIME LOSSES ON ASPHALT CONSTRUCTION WORK, EMANUEL COUNTY, GEORGIA

Major Delays to Production—Includes Only Definite Stops or Delays Each of Fifteen Minutes or More Duration

Cause	Hours Lost	Per Cent of Total Available Time
Weather (rain and wet subgrade)	252.0	31.8
Moving plant to second set-up	71.0	9.0
Plant breakdowns and mechanical trouble	32.8	4.1
Changing from top to base, etc.	10.5	1.3
Miscellaneous causes	29.0	3.7
Total time loss	395.3	49.9
Total time available	793.0	100.0

Minor Time Losses—Each of Less Than Fifteen Minutes Duration

Cause	Per Cent of Total Working Time
Waiting for trucks	4.5
Mixer, operator	2.1
Mixer, mechanical trouble	0.8
Elevators, mechanical trouble	1.3
Drier, mechanical trouble	1.2
Drier, waiting for hot materials	8.4
Asphalt heater	0.9
Asphalt pump	0.2
Power plant	1.7
Batcher, mechanical trouble	2.0
Miscellaneous	2.3
Total	25.4

TABLE II—TIME LOSSES ON BITUMINOUS CONCRETE CONSTRUCTION WORK, MONROVIA, CALIF.

Major Delays to Production—Includes Only Stops Each of Fifteen Minutes or More Duration

Cause	Hours Lost	Per Cent of Total Available Time
Truck shortage	1.5	1.1
Mixer trouble, mechanical	0.5	0.4
Finisher, mechanical trouble	0.5	0.4
Screen clogged	0.5	0.3
Total time losses	3.0	2.2
Total time available	136.0	100.0

Minor Time Loses—Each of Less Than Fifteen Minutes Duration

Cause	Per Cent of Total Working Time
Waiting on trucks	11.8
Drier, waiting for hot materials	9.2
Asphalt filling and emptying can	4.6
Mixer, mechanical troubles	1.5
Mixer, operator	1.0
Screens	0.2
Miscellaneous	0.5
Total	28.8

But in the matter of minor delays this job was not so fortunate. The record shows that an average of 28.8 per cent of the time was lost in minor delays varying from a few seconds to five or ten minutes each. Even during the best week these delays absorbed 25 per cent of the working time. The largest and most persistent cause of this loss, amounting to 11.8 per cent, was the lack of really sufficient trucks and the fact that those on the job were not operated on any regular schedule but were allowed to bunch up from time to time. This plant had no hopper or "gob box" for storing the mixed batches, but each batch was dumped directly into a waiting truck. The batch weighed 4,000 lb. and each truck carried three batches. Consequently, whenever a truck was not immediately on hand to drive under, the mixer was forced to wait until one arrived. A "gob box" which would have held three batches, or a full load, not only would have decreased the loading time of the trucks but would also have absorbed a reasonable factor of variation in the flow of the truck supply.

The next large factor in causing these minor interruptions to steady production was drier delay, which absorbed 9.2 per cent of the working time. Nearly all of this delay was due to poor regulation of the correct proportion of the various sizes as fed into the cold elevator. This frequently caused either a shortage or an overflow of hot materials in some one of the four hot bins. In other words, the usual methods of feeding the cold elevator with materials for bituminous concrete are difficult to work so that the supply of each of the several sizes going into the drier will always be in the right proportions. Sooner or later we shall no doubt develop some thoroughly practical method of properly proportioning the materials as or before they enter the drier. This should prevent a considerable loss in heated material which must now be run out of the overflow bins, and it should also cut down the heat losses in the present long passage of the materials between the drier and the minor insert.

Poor asphalt handling on the job referred to above also accounted for a total of 4.6 per cent of the lost time. Where a large batch is used, the question of handling the rather large volume of asphaltic cement must be worked out very carefully, otherwise time is likely to be lost regularly with each batch. Even comparatively small individual time losses of this kind often accumulate to a rather surprising total during the course of a day. On this job the mixer gave a little trouble and the operator did not seem to be aware of the value of seconds, so that an average of 2.5 per cent of the available time was wasted here. Miscellaneous time losses from various causes consumed an average of 0.7 per cent of the time, completing the total of 28.8 per cent time loss.

The effect of these time losses on the unit cost of this job may be worth an examination. The hourly operating cost, including labor, supplies, rental value of equipment and overhead, exceeded $100 an hour with a production of about 75 tons an hour, or approximately $1.35 per ton. If all the time losses could have been eliminated, the contractor could have placed 104 tons an hour with probably only the added hourly cost of two or at the most three extra trucks to haul the additional tonnage to the road. The unit operating cost could then have been cut to about $1.05 per ton, a reduction of 30 cents a ton. In other words, the total elimination of just these minor delays, each of so short duration as generally to escape notice except under the most careful observation, would have been worth more than $200 per day to the right side of the contractor's ledger. Even the reduction of his time losses by one-tenth would have amounted to about $20 per day—surely, a worth-while accomplishment.

* * *

Asphalt Service Records in Michigan

By V. R. Burton

Engineer of Research and Statistics, Lansing, Mich.

THE accompanying table gives the information from which service results may be estimated. The jobs listed include all those on which continuous maintenance records of any length were obtainable. The yardage shown includes about 55 per cent of the total yardage of asphalt roads of the Michigan state system. They have been separated into those roads with rigid base and those with flexible base and are listed in order from the newest to the oldest.

In several cases the width as given is not quite accurate, as there are short stretches of 20-ft. pavement at the entrance to a city or village. These do not amount to more than 5,000 or 6,000 sq.yd. per job and cannot seriously affect the conclusions. The traffic given is the average traffic over the period noted. Jobs Nos. 1 and 2 are for the period 1921-23 inclusive, while Job. No. 8 is from 1920-26 inclusive. All other records date back from 1928. Only trucks of more than 1½-ton capacity and buses are included in column 8, while in column 9 total motor vehicle traffic is given.

The costs given include the filling of surface cracks twice annually, patching of both wearing surface and

STUDY OF ASPHALTIC CONCRETE SERVICE RESULTS IN MICHIGAN

Job. No.	Sq.Yd. Represented	Width Ft.	Age Period Involved	No. of Years Record	Design—Base	Design—Top	Daily Avg. No. Heavy Trucks and Buses	Daily Avg. Total Traffic	Avg. Annual Maint. Cost Per Sq.Yd. in Cents
			Asphaltic Concrete on Cement Concrete Base						
1	47,921	18	1–4	3	6 in. cem. conc.	2 in. Topeka	13	1,307	0.640
2	118,464*	18	1–4	3	6 in. cem. conc.	2 in. Topeka	40	1,493	0.781
3	112,337	18	1–6	5	6 in. cem. conc.	2½ in. sheet	37	1,283	1.116
4	140,866	18	2–7	5	7 in. cem. conc.	2½ in. sheet	83	2,319	1.132
5	209,521	18	1–8	7	6 in. cem. conc.	2 in. Topeka	62	1,629	2.254
6	106,096	18	1–9	8	6 in. reinf. c.c.	2 in. Topeka	236	3,370	1.602
7	195,278	18	4–9	5	6 in. cem. conc.	2 in. Topeka	62	1,720	2.967
8	53,787	16	4–10	6	5 in. cem. conc.	2 in. Topeka	16	449	0.620
9	141,391	24	1–11	10	7 in. cem. conc.	3 in. sheet	217	3,934	0.745
	1,125,661								
	118,464—Duplicated yardage.								
	1,007,197—Total yardage.								
			Asphaltic Concrete on Flexible Base						
10	152,877	18	1–3	2	Gravel	2 in. stone-filled sheet	67	1,993	0.240
11	111,271	18	1–3	2	Gravel	2 in. stone-filled sheet	147	1,855	1.130
12	90,742	18	1–4	3	Gravel	2 in. stone-filled sheet	28	901	0.267
13	83,297	18	1–5	4	Macadam	2 in. stone-filled sheet	24	1,219	0.728
	438,187								

base, or any other cost which pertains to pavement only. Average costs over the entire period are used, because it is felt that they are much more indicative of true cost than would be a study of costs from year to year. The tendency in maintenance on rural highways is to make more or less temporary repairs on the surface each year until enough work has accumulated to justify the placing of equipment on the road suitable for permanent repair. This makes for annual costs which gradually increase up to a certain point and then take a sudden rise for the next succeeding period in which costs start rising again. Fortunately for our averages, 1927 and 1928 were years of adequate maintenance funds and most of the pavements needing it received permanent repairs in either one or the other of these two years.

Job No. 2 is a part of Job No. 7, on which the costs were kept separately for the first three years and after that were thrown into the same maintenance section. Jobs No. 5 and No. 7 are not satisfactory under the traffic they are now carrying, and will need reconstruction in a few years. Job No. 6 is on the ragged edge of a complete resurface.

Summing up the conclusions that may be drawn from service results, we feel justified in saying that under the particular conditions existing in Michigan:

1. Five-inch plain cement concrete base is inadequate unless the number of heavy units and total traffic over the road is very small.

2. Six-inch plain cement concrete base is unsatisfactory unless the average number of heavy units passing over it is less than 40 per day.

3. Seven-inch plain cement concrete base is satisfactory for traffic up to an average of 100 heavy units per day, if the width is 18 ft.

4. Seven-inch plain cement base on a pavement width of 24 ft. is satisfactory up to an average of at least 250 heavy units per day and probably many more.

5. Forty-pound mesh reinforced cement concrete base, 6 in. thick, is about equal to 7-in. plain base.

6. Maintenance costs over a period of ten years may be kept at an annual average of less than one cent per square yard where the design is fully adequate for the traffic carried.

7. Maintenance costs which average more than two cents per square yard over the first ten years indicate unsatisfactory pavements.

8. With traffic under 70 heavy units per day, asphaltic concrete on flexible base shows a lower annual maintenance cost than with a 6-in. plain cement concrete base.

9. In general a sheet asphalt mixture is more suitable to rural highways than is the Topeka mix.

* * *

Individual Study of Fillers Is Required

By Hugh W. Skidmore

Chicago Paving Laboratory, Inc., Chicago, Ill.

THE greatest single factor in the stability of normal asphalt mixtures is the filler. Increase of filler means increase in resistance to displacement without decrease in workability or compressibility when the volume of bituminous cement is maintained in proper relation to mineral aggregate. Rational treatment of the filler portion of the mixture is the most powerful single factor for good available to the designer. A wide variety of both fine and coarse aggregates may be used without too great refinement, likewise any and all of the asphalt cements now available and complying with standard requirements are perfectly safe and need give nobody a moment's worry, if they are not misused. A variety of filler materials are also entirely suitable for use, but no two are alike and each must be thoroughly determined. To my mind the subject of fillers is the least understood and the most important factor in mixture design; it provides the most fertile field for further research in both the practical and purely scientific directions.

* * *

Asphalt Joint Fillers for Brick Pavement

By Harry J. Kirk

State Director of Highways, Columbus, Ohio

WE HAVE been able to a large extent to overcome the difficulty of excess filler by applying the asphalt with what is known as a squeegee bucket. The hot asphalt instead of being dumped directly into the pavement is poured into the tank of the machine and is released through a valve at the bottom as needed. It is distributed by means of a rubber and fabric squeegee attached to the machine. It is possible in this way to fill the joints to within $\frac{1}{8}$ to $\frac{1}{4}$ in. of the top and leave a film of asphalt only about $\frac{1}{32}$ in. thick on top of the brick. The use of this machine has been encouraged in Ohio and will probably be required in the specifications in the near future.

There seems to be a vast difference in the time it takes various asphalts to become worn off or to chip off the surface of the pavement. This is influenced to a large extent, of course, by the kind and condition of the brick and the volume of traffic, but even so it seems that under comparable conditions two fillers, both of which meet the specifications, will give widely different results as to the tenacity with which they cling to the surface of the pavement.

The greatest forward step that can be made in the manufacture and use of asphalt fillers for brick pavements is to prevent, in so far as possible, this excess asphalt on top of the pavement, to furnish an asphalt that will wear off the surface of the brick as quickly as possible and at the same time remain in the joint to keep it permanently sealed. In view of the fact that certain fillers, apparently satisfactory in other respects, disappear from the surface much sooner than others, it is believed that some very helpful work could be done along this line.

* * *

Penetration Road Service in Massachusetts

By V. L. Ostrander

Manager Eastern Branch, Asphalt Association, Boston, Mass.

ASPHALT macadam using the heavier grades of binder was first used in Massachusetts about 1909. Prior to that time a hot oil binder had been largely used. The change was beneficial and the further development of the type received study. Methods, materials and machines for its construction were perfected until today asphalt macadams in that state are undoubtedly the equal of the very best to be found anywhere and actually compare most favorably with much more expensive pavement types. The standard specifications for asphalt macadam are summarized as follows:

Foundation—12 in. gravel (minus 4-in. size) plus 4½ in. of crushed stone; or 10 in. stone fill plus 2 in. of crushed stone.

Top Course—2½-in. course (1¼-in. to 2½-in. size) of trap rock or its equivalent. Keystone ¼ in. to ¾ in.

Asphalt—2¾ gal. first pour, ¼ gal. second pour, 85-100 penetra-

tion No application at air temperature below 50 deg. F. Adequate pressure maintained to the end of the pour. (40-60 lb.)

Rolling—One 10-ton roller per 100 tons of stone per eight hours, in addition to other courses. Back rolling one-half day on each 500-ft. stretch.

These roads present a rather "toothy" surface to traffic, with no surface mat, the stone taking the wear. They offer a driving surface that is safe at all times and under all weather conditions. Ten to twelve years without oiling is the usual practice; many go longer. Some of the first-built roads have never yet been resealed. Great care is taken to prevent inexperienced maintenance men from oiling these surfaces before it is necessary.

For city streets the practice is varied somewhat to meet the necessity for frequent cleaning. The variation is generally a third application of asphalt or 85 per cent asphaltic oil at the rate of ⅓ gal. per square yard applied about one month after the street is otherwise complete. This is covered with clean fine gravel, well rolled, with the excess later removed. This gives a dense, smooth, easily cleaned surface that can scarcely be distinguished from sheet asphalt.

Penetration macadam base is being considerably used and gives uniformly satisfactory results. It is generally of the same specification as wearing course, with 1½ gal. single pour. It makes a much firmer base on steep grades than does ordinary sand-filled crushed stone as well as being of greater supporting power under heavy traffic.

A discussion of suitability would not be complete without reference to initial cost. For pavement widths of 20 to 24 ft. the comparative costs of the three most used types in Massachusetts per mile of complete road are approximately as follows:

Penetration macadam	$40,000 per mile
Asphaltic concrete	20,000 per mile
Reinforced concrete	60,000 per mile

It is always difficult to arrive at proper conclusions as to highway maintenance cost, as this item is so variably affected by the complex factors of comparative age, traffic, soil conditions, standard of maintenance, etc. Frequently the money available rather than the condition of the pavement governs the maintenance cost. Averaging from many miles and from many sections under the same maintenance authority and from projects of approximately equal ages serves to minimize this variation. To this end all of the federal-aid highways in the state were selected for consideration as to maintenance cost, the records for 1927 being as shown below.

Type	Miles	Total Cost Per Mile	Surf. Only Per Mile	Age, Years
Cement concrete	39.3	$625	$298	6–10
Reinforced cement concrete	132.5	545	118	1–6
Bituminous concretes	44.6	320	57	1–9
Bituminous macadams*	221.7	480	174	1–9
Dual	3.7	951	297	2
Gravel	1.0	899	668	Temp. only
All types	442.8	501	159	

*This includes both asphalt and tar macadam, and both gravel and stone fil foundations.

It should be stated that most of the asphaltic concretes are really sand asphalts of special design for the special conditions obtaining on Cape Cod.

Metcalf & Eddy Report on Wanaque Aqueduct

ENGAGEMENT of Metcalf & Eddy, of Boston, Mass., to report on one of the many changes in designs for the Wanaque aqueduct proposed since the commission adopted the original Pratt and Sherrerd plans in 1924 was announced in *Engineering News-Record*, Aug. 16, 1928, p. 258. The Metcalf & Eddy report has not yet been published, but its main findings have been announced in the local press, most fully in the Newark *News* of Dec. 13. The Boston engineers were employed by three of the eight contracting municipalities—Montclair, Bloomfield and Glen Ridge—for which the Wanaque project is being executed by the North Jersey District Water Supply Commission. They were asked, in substance, to advise the three municipalities whether they should sign a supplementary contract with the commission, necessary to provide funds to build the aqueduct. Although not approving the plans referred to them, Metcalf & Eddy advised signing the contract rather than cause further delay in completing the project and because of the fact that these three communities have been relieved of their share of certain construction costs.

Conclusions quoted by the Newark *News* from the Metcalf & Eddy report are:

Twin steel lines of present plan do not have sufficient capacity, unless supplemented by pumping at the dam.

Installation of pumping station at Wanaque dam is undesirable.

Use of twin steel lines unnecessary and is expensive as compared with a single line of equal capacity.

A more permanent and more economical aqueduct can be obtained through use of a single steel pipe with cement mortar lining and outside concrete protection and of sufficient size to provide for the maximum flow without pumping.

The Boston engineers estimated that an aqueduct having at its upper end a single 108-in. pipe of the kind outlined just above would cost $7,326,100, compared with their estimate of $7,149,200 for the twin 74-in. conduits at the upper end, and that the single conduit would save the necessity of pumping to insure a delivery of 150 m.g.d. if the 74-in. twin conduits were used. Capitalizing operating costs at 6 per cent, Metcalf & Eddy put the cost of the single line at $6,428,000 and of the double line at $7,544,000, a saving of $1,116,000 for the single line. The above estimates of cost exclude rights-of-way and proposed strengthening of the existing portions of the aqueduct.

As to aeration at the Wanaque reservoir, abandoned by the commission in 1927 on recommendation of George A. Johnson, restored after his subsequent dismissal, and again provided for under the Fuller & McClintock plan, but necessitating pumping to the aerator, when aeration is deemed necessary, Metcalf & Eddy say that aeration is advisable. The Boston engineers failed to see why the whole district represented in the pact should be called upon to pay pumping charges at Wanaque dam for the benefit of Kearny, which would be relieved of installing its own pumping plant for its own heights. It should be interjected that some readjustment of costs entailed by pumping to the aerator has been made since Metcalf & Eddy were engaged.

The engineers just named stated in their report as follows: "From the standpoint of safety against damage, the twin line plan affords little protection. In this plan the two pipes are placed with a clearance between them of but 3 ft. Should a serious accident occur to one of them involving a break, the resulting washout would probably put the second line out of service."

For a long list of earlier articles dealing with plans and counter plans for the Wanaque aqueduct see *Engineering News-Record*, Oct. 4 and Dec. 13, 1928, pp. 523 and 891.

Bids for the Wanaque aqueduct were received Dec. 20, 1928, as summarized in the news section of this issue. The contract was awarded to the T. A. Gillespie Company at $5,127,628.

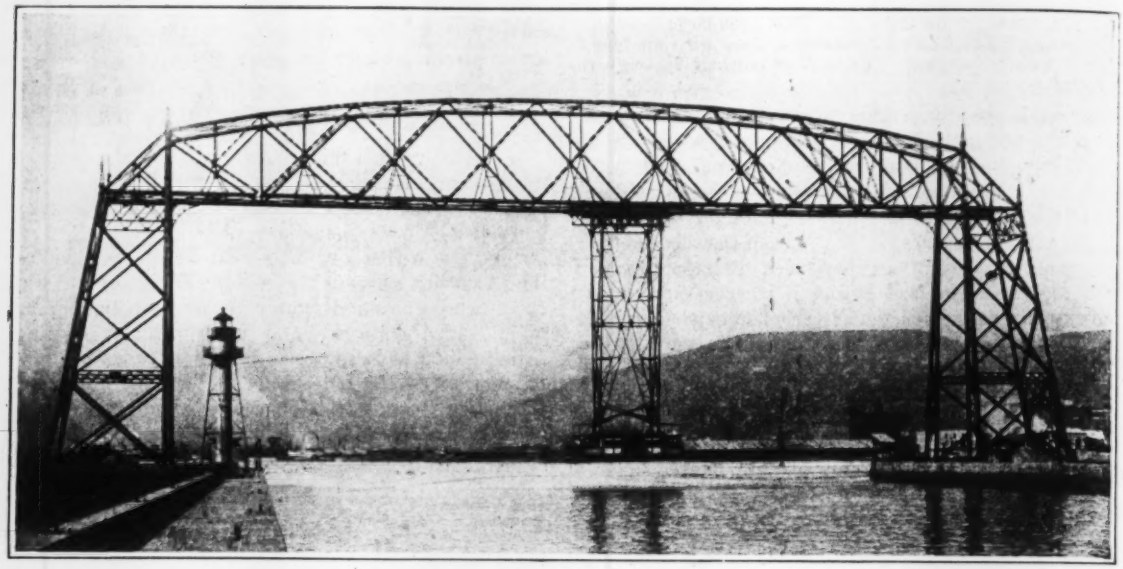


Fig. 1—Present Ferry Bridge at Duluth, Minn.

Lift Span to Replace Duluth Ferry Bridge

Old Structure of Unique Type Will Be Raised and Strengthened to Carry Bridge Replacing Ferry Car—Present Clearance Height to Be Maintained

By Ernest E. Howard
Ash-Howard-Needles & Tammen, Consulting Engineers, Kansas City, Mo.

BECAUSE of the inadequacy of present facilities, the city of Duluth, Minn., has found it necessary to replace the ferry car of the old Lake Ave. South bridge with a lift span of modern type which will provide more continuous service. This structure across the 320-ft. artificial entrance to Duluth harbor connects the mainland with Minnesota Point, a natural breakwater 500 to 700 ft. wide and nearly 7 miles long which separates the harbor from Lake Superior. The present ferry bridge, illustrated in Fig. 1, consists of a truss span 394 ft. long carried on two towers at a height of 135 ft. above the water level, supporting a suspended ferry car, which moves across the canal. It is believed to be the only one of its kind in this country and is fully described by C. A. P. Turner, the designer, in *Transactions*, Am. Soc. C. E., Vol. 55, p. 322 *et seq.*

With the growth of the city and the increased traffic, particularly automobile traffic, the intermittent service of the ferry car has become irksome and unsatisfactory to the citizens residing south of the canal. This condition has led to efforts to secure the construction of some type of bridge which could give more continuous service, and has finally resulted in the provision of funds by a city bond issue supplemented by special assessments of properties on the Point.

The problems of navigation through the canal are unusual in that the approach to the canal is difficult and, in stormy weather, vessels must have free passage without any hindrance. During each open season of navigation, lasting about nine months each year, about 9,000 vessels pass through the canal, most of them large and heavily laden ore boats. The location is quite unprotected and subject to frequent heavy wind storms. The ferry bridge was devised as a solution to these problems and to overcome the strenuous objections of shipping interests, which had prevented the construction of any new bridge for the previous fifteen years.

A study of these conditions resulted in the conclusion that a vertical lift span offered the most feasible solution, partly because of the rapid operation possible and the small effect of wind loads on the operating machinery. Estimates indicated that this could be built for less cost than any other type of movable span suited to the conditions. Conferences with the Captains' and Pilots' Association of Duluth and with the Lake Carriers' Association resulted in a statement of conditions which they felt would meet the requirements of navigation and which could be provided in the design. After the passage of a Congressional act, approval was received from the War Department, the latter including a number of special provisions concerning operation. Final plans and specifications for the bridge have been prepared, and bids were received Oct. 20.

General Plan—The new structure will be at the same site as the present ferry bridge, and parts of the existing structure will be incorporated in the new construction. The bridge comprises a vertical lift span 395 ft. long with a roadway 24 ft. wide and two 5-ft. sidewalks. The roadway will contain two street-car tracks. Floor and sidewalks will be of special lightweight concrete averaging 105 lb. per cu.ft. in weight. The span will be suspended from two new towers constructed within the existing towers. The columns of the new towers are 27 ft. 6 in. centers transversely; the existing columns are battered and, at the ground, 47 ft. 6 in. apart. The existing overhead truss span will be retained, but

will be raised about 60 ft. above its present position and supported upon the new towers. The old towers will be built up to this new height, but will not support any dead load either of the lift span or of the overhead truss span. They will, however, be connected to the new towers so that the two will act together for wind and lateral stresses. The existing overhead truss will be retained in the structure to provide support for water pipes, gas pipes and other utilities. It is not otherwise essential to the new structure, but will retain the characteristic appearance which has come to be considered a landmark of Duluth. The new span will lift to a clear height of 135 ft. above high water, which is the present position of the existing overhead truss. There will be

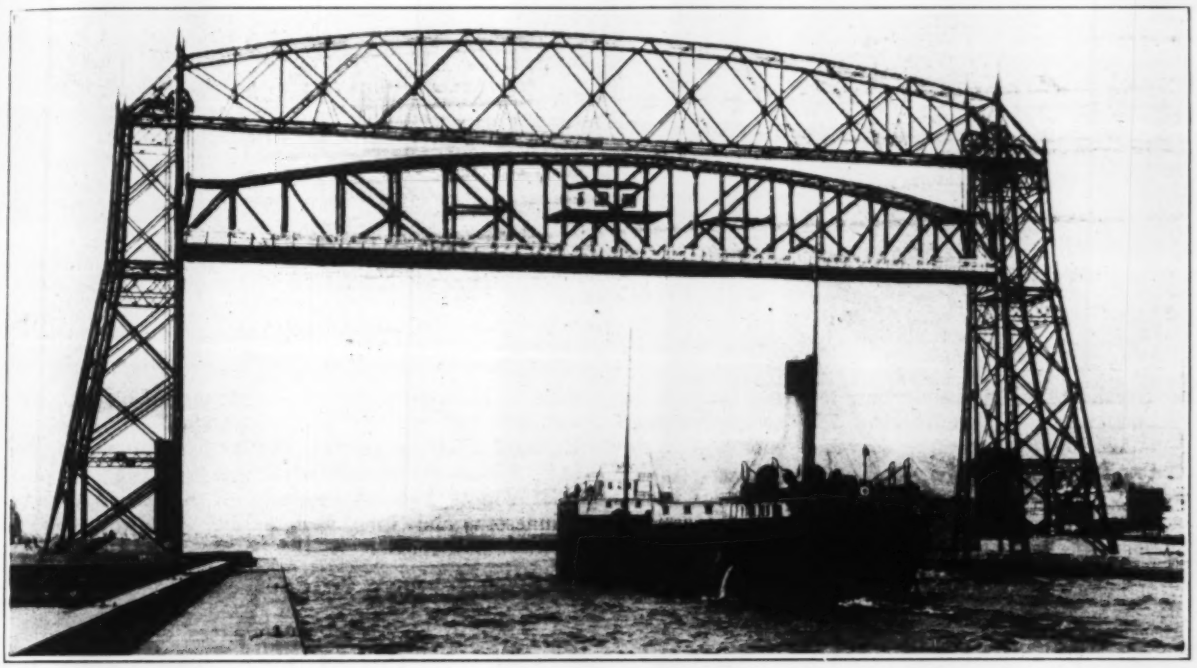


FIG. 2—OLD TOWERS AND SUPPORTING TRUSS WILL BE RETAINED, FERRY CAR WILL BE REPLACED BY LIFT SPAN
Truss will be raised and supported on new towers inside the present ones, which will be used as bracing against wind and lateral stresses.

suitable concrete spans under the towers and approaches to street grades at each end of the structure.

The urgent necessity for certain and rapid operation under every condition resulted in a stipulation that the power for operating the bridge should be independent of the city supplies and not subject to interruption from accidents to supply lines or to the power plants. Operation will be from a storage battery located in a battery house adjacent to the south end of the bridge. This battery will consist of 153 cells of the chloride accumulator type with automatic control for charging. Under normal conditions the battery will be charged by a motor-generator set operating on alternating current from the power company's lines. A gas engine generating unit will also be provided in the battery house for use in the event of failure of the current from the power company.

The lift span will weigh 1,300 tons and the concrete counterweights the same. Balance chains will compensate for the weight of the suspending ropes. The span will lift 125 ft. to its clear height of 135 ft. in 60 seconds. The operating machinery is to be located on the span and will comprise spirally grooved operating drums engaging operating ropes which pass over deflector sheaves and up and down the towers at each corner of the span. The power will be supplied by two motors, each of 200 hp., arranged for series-parallel operation and acceleration by means of time-limit relays. Two reserve motors will be provided, all four being directly coupled to the machinery. Suitable switches for disconnecting either of the two motors in use and throwing in a spare motor are included in the plans. Power will be supplied from the storage battery to the motors by trolleys engaging on vertical trolley wires on the south tower. An auxiliary gasoline engine of about 240 hp. will be installed in the machinery house on the span to operate the span in emergency if all electric operation should fail.

There are electric roadway gates of railroad crossing type and traffic lights at each end of the bridge to direct and control highway traffic, and audible and visible vessel signals for responding to signals from the vessels. These are all controlled by the bridge operator on the span.

The new foundations will be supported upon piles,

DESIGN LOADS FOR DULUTH HARBOR LIFT BRIDGE

LIVE LOADS

Floor Systems:
Highway, two 15-ton trucks passing at 9-ft. centers; electric railway, two 40-ton cars on each of two tracks.

Trusses:
Train of two 40-ton cars per track followed or preceded or both by a highway load of 450 lb. per linear foot plus 21,000 lb. concentration per 9-ft. traffic lane.
On sidewalks, a uniform load in pounds per square foot equal to $(70 - 0.109\ L)$, where L is the loaded length in feet.

IMPACT

Floor System:
Highway and electric railway, 30 per cent. End floorbeams, hangers, and floorbeam end connections, 60 per cent.

Trusses:

$$I = \frac{6(L + 250)}{7(10L + 500)}$$

L = loaded length in feet.
I = impact in per cent of live load.
No impact for sidewalks.

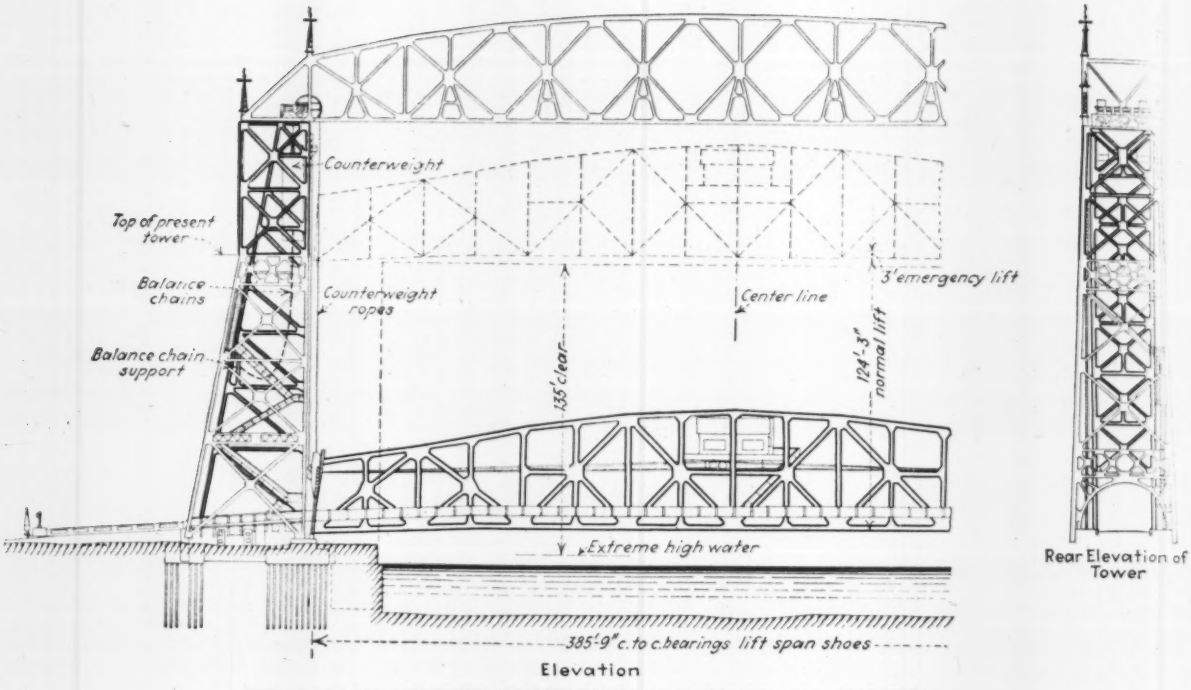


FIG. 3—PLAN SHOWING UTILIZATION OF NEW AND OLD MATERIAL
Heavy lines show new steel to be added to old structure.

as are the existing foundations, and will be built between the existing foundations. All construction operations which would interfere with navigation will be carried on during the season when navigation is suspended.

Construction—The erection program provides for the construction of the new substructure and the building thereon of the new towers complete. The existing overhead truss will be lifted to its new position by use of the main lifting sheaves on the new towers. After these sheaves are erected some of the permanent suspending ropes will be put in place and attached to cross-girders set underneath the existing truss span, which will be reinforced slightly by certain additional members for this raising. The counterweight frames will then be loaded by suitable amounts and the span lifted to its new position. Cantilever brackets on the outsides of the new tower columns which are to support the overhead truss will then be placed and the span rested upon them. The new sections of old towers will be built up to connections with the overhead trusses.

The permanent counterweights will be built upon temporary beams placed in the new towers and all of the suspending ropes connected. Silicon steel will be largely used in the lift span, which will be built adjacent to position on the canal walls and later rolled into place, or possibly floated from some other erection site. The operating ropes will then be connected to the towers and the span adjusted for operation.

The new structure was designed by Harrington, Howard & Ash, Kansas City, Mo. P. G. Phillips is commissioner of public works and John Wilson city engineer for the city of Duluth. The engineers as well as the city officials have had the assistance and counsel of an advisory board of engineers appointed by Mayor S. F. Snively, composed of engineers resident in Duluth. The function of this board is to aid the city council in its deliberations and to advise on general considerations and policies, services which are rendered as civic obligations. This advisory board is made up of O. H. Dickerson, principal assistant engineer, Duluth & Iron Range Railroad, chairman; E. H. Dresser, chief engineer, Duluth, Missabe & Northern Railway; S. H. Shepard, chief county highway engineer of St. Louis County, Minnesota, and John Wilson, city engineer. V. L. Fixen was a member of the board until his departure from the city.

Road Capacity Decreases as Auto Speed Increases

Abstract of address delivered by E. W. James, chief, division of design, U. S. Bureau of Public Roads, Oct. 16, before the Philadelphia Engineers Club

THE trend toward increasing automobile speed limits or removing them altogether for the purpose of moving more vehicles per hour over a given road and alleviating congestion will not accomplish its purpose, according to investigators. This fact has been confirmed by tests made by the Bureau of Public Roads. A maximum traffic lane capacity, computed on a mathematical basis by Dean A. N. Johnson, is to be obtained at a speed of 15 m.p.h. with vehicles operating under safe conditions. The State Highway Department of Pennsylvania gives 22 m.p.h. as the speed producing maximum road capacity at safe braking distance.

Tests by the Bureau of Public Roads were made in vicinity of Cleveland where a great variety of traffic is found. A test car carrying a spare-time recording apparatus was driven in the regular flow of traffic, retaining its relative position in the line. Thus if one car passed the test car, it was instructed to pass one car but it was not permitted to weave in and out to gain advantage of position to increase its speed. A careful traffic count was made and a recorder in the test car kept notes during the run.

The following figures are results obtained when congestion was just avoided:

In a two-lane road 3,000 vehicles per 24 hours moved at an average possible speed of 36 m.p.h., 4,000 vehicles per 24 hours at 34 m.p.h. and 7,250 vehicles per 24 hours at 25 m.p.h.

On a road unnecessarily wide for two lanes but not qualified for three lanes, 8,500 vehicles per 24 hours averaged 28 m.p.h. and 12,250 vehicles per 25 hours 24 m.p.h. Considered as a three-lane road, figures per lane in this test agree with the first test.

On a four-lane route, 12,000 vehicles per 24 hours averaged 29 m.p.h.; 11,000 vehicles per 24 hours, 28 m.p.h.; 29,000 vehicles, 24 m.p.h., and 32,000 vehicles, 23½ m.p.h.

On other routes, with more refined study, the results were: On a six-lane road, 1,300 vehicles per hour made a speed of 16 m.p.h. and 1,700 vehicles per hour a speed of 14 m.p.h.; on a four-lane road, 1,300 vehicles per hour made a speed of 16 m.p.h. and 1,500 vehicles per hour a speed of 9 m.p.h.

Results of these tests indicate that speeds greater than 20 to 25 miles are not necessary to relieve congestion. On the other hand, these studies will enable the engineer to base highway design on capacity or speed desired. It will be possible to design a road for a given speed—say 25 miles per hour. If the public wants more speed it must pay for more traffic lanes.

International Water Problems Under Investigation

Many questions arising from the use of water flowing between the United States and Canada are under investigation by the U. S. Department of the Interior, it is announced. Among these the Kootenai River in northern Idaho is the most important and presents what is termed "a little Mississippi River problem." The Kootenai is a typical mountain river above Bonners Ferry, Idaho, at which point it slows down and meanders through an alluvial valley about 3 miles wide between confining foothills, passing into Kootenai Lake across the border. Since the river bank is higher than the surrounding flats, the whole valley is flooded each spring when warm weather causes a heavy concentration of snow water. Considerable areas in the United States have been reclaimed for agriculture by diked drainage districts, which have been partly successful, although much pumping is required in high water and some crops have been lost through dike failures. A proposed power project at the outlet of the Canadian lake would, it was claimed, practically wipe out the farming interests.

The settlement of such cases is to be made through the International Joint Commission according to the 1909 treaty provisions. In order to provide base data for solving the Kootenai problem, the State Department has made an arrangement with the U. S. Geological Survey whereby a comprehensive investigation is under way. The work includes a large-scale topographic map and the construction of many steam-gaging stations on the river and its tributaries. Measurement of discharge is highly complex because of such factors as flood storage and the large indeterminate flow across the flats. Control stations are maintained on the upper river and slope cross-section stations through the part subject to backwater.

Investigations of border streams are also being conducted on the Milk and St. Mary's rivers in Montana, the Rousseau in Minnesota, the Skagit in Washington and on branches of the Columbia.

Engineering Problems of the Chicago Region

In the article "Engineering Problems of the Chicago Region and Their Solution" in the issue of Nov. 22, 1928, an illustration on p. 763 shows allocation of underground space for conduit. This illustration has three road sections, the upper showing, at the right, the gas main location. The lower two show the same main location, but it is marked "sewer" in each case. This was an error and the marking should have been "gas" in all three places.

Letters to the Editor

Concerning Shrinkage of Concrete

Sir—Replying to A. W. Knight's letter in the Nov. 23 issue, p. 781, criticising my article in the Oct. 4 issue, p. 507, I should like to call attention to several remarks made by Mr. Knight. In regard to Mr. Knight's criticism of the accuracy of the measurements, the writer calls attention to the fact that he employed the same methods of measurement used by Franklin R. McMillan in his studies of the "Shrinkage and Time Effects in Reinforced Concrete" (see "Studies in Engineering," No. 3, Bulletin of the University of Minnesota, March, 1915). To quote a portion of this: "Upon completing a set—that is, after reading in order once through all of the gage lines—the movable scale of the gage is shifted and a new set begun. The effect of this shift is to make entirely different numerical values in the readings on the standards as well as on the other gage lines of the set. But the difference between the reading on any particular gage line and the reading on the standard is unchanged by this shift, and these differences, worked out as the observations are recorded, furnish the means of averaging the successive sets. As an aid to free and rapid work on the part of the observer, this shift has proved most valuable, as it frees him from an otherwise inescapable memory and gives him the assurance of an absolutely reliable check on his observations."

It is the writer's belief that in casting the specimens and in taking the readings both as to method and frequency he followed accepted scientific practices. All readings were made with a Berry strain gage. For the mortar beams, readings were taken daily during the very first period of the test and then at intervals of three or four days. For the concrete beams, readings were taken daily during the first part of the test and then at intervals of about three days up to the period when the beams were covered with wet burlap, when daily readings were resumed. After this period readings were taken at two-day intervals. The readings of each concrete beam were averaged (there being two 8-in. spaces between the plugs). The averages of the averages (two sets) were taken to furnish the data necessary to plot the graphs in Fig. 3. Each point, therefore, represents the average of eight individual readings.

Mr. Knight states: "We particularly call attention to the fact that the tests actually showed less shrinkages in 1:1½:3 and 1:2:4 Celite concrete mixtures than for the corresponding plain concrete mixes. This fact is entirely lost sight of, however, in your sub-title which merely states: 'While Tests Show Concrete Is Less Affected.'" The writer's article states very specifically that "in the 1:1½:3 and the 1:2:4 beams the increase in shrinkage over the plain beams is not very great and occurs during the first five days. Beyond that period and up to the time the beams were covered with wet burlap there is a slight decrease in shrinkage." The writer did not write the sub-title nor did he see the proof of the article before its publication.

In reply to Mr. Knight's statement that no consideration was given to the question of improved workability which can be obtained with Celite concrete at a drier consistency than would be used for plain concrete, the writer wishes to state that Mr. Knight ignored one very important fact—namely, that unbiased comparisons must be made between specimens that are constituted the same. He forgets that in order to keep the water-cement ratio constant in both the plain concrete and in the Celite concrete, it was necessary to add an amount of water to the Celite specimen equal to

about 200 per cent of the weight of the Celite in order to offset the free water which is absorbed by the Celite. If no additional water is added to the mix when Celite is incorporated, then the effective water-cement ratio is not the same as the water-cement ratio of the plain mix. In all fairness to plain concrete, the water-cement ratio of the plain concrete should be made the same as the effective water-cement ratio of the Celite concrete (to which no additional water has been added). This could be accomplished by adding more cement, thus making the slump practically the same as the Celite mix, and insuring both increased workability and increased strength.

In conclusion the writer's interpretation of the test results is that if Celite is used in a 1:1½:3 or a 1:2:4 mix, there is no apparent danger so far as shrinkage is concerned. If you use Celite in the leaner 1:3:6 mix and add no water to offset the absorption by the Celite, the writer feels that the shrinkage factor is not a serious one in this mix. The fact to be stressed is that, in the writer's tests, the slump was kept constant in both the plain and Celite mixes. This was done in order to make a fair and unbiased comparison of the plain concrete with the Celite concrete.

A. S. LEVENS,
Department of Drawing and Descriptive Geometry,
Minneapolis, Minn., University of Minnesota.
Dec. 15, 1928.

Regional Engineering

Sir—Charles H. Diggs, director of our commission, asked me to review and comment on your article in *Engineering News-Record* of Oct. 4, p. 496, on "Regional Engineering." The article struck my attention as soon as my copy arrived. As I read and digested it, I underscored certain phases.

To begin with, let me highly commend your selection of the term "Regional Engineering." All technical men who have dealt with municipal problems to any degree have been forcefully impressed by the need of co-ordination and planning in the designing, financing and construction of those paramount requisites which are common to all municipalities. I have often felt the weakness of the term "city planning" or "regional planning"—it falls short of the problem and the exactness which must be recognized in the solution thereof. A more proper term would be "regional engineering and planning."

I want to cite for your attention the several paragraphs which I underscored because I felt they forcefully express the situation as it applies to all the major regional areas throughout the United States.

1. Almost over night regional engineering has become a country-wide necessity.
2. We see that the greatest obstacle is the lack of governmental machinery.
3. Rapidly growing cities are constantly throwing out suburban fringes, extending farther and farther from their centers.
4. There results a pressing need for revision and interconnection of the transport, water supply, sewerage, drainage and other utility facilities.
5. Water-supply and sewerage facilities are fundamental to modern civilized existence. They necessitate skillful planning to anticipate demands.
6. The engineering problems of a region are seriously complicated by political problems. A mere glance at the map of the metropolitan region will bring some of these political problems to mind.
7. Some troubles of boards and districts, etc.
8. At present too many city officials are unable to see beyond their boundaries and they must learn to appreciate the need for orderly development beyond the city confines before this new unit, the region, can be brought into existence successfully.
9. Official status is desirable in that it would provide finances for a continuing program.
10. Regional engineers are learning, as city engineers have already learned, that the public will take fright if too much is presented for immediate execution, but that without comprehensive, well-scheduled programs, looking years ahead, regional engineering cannot meet regional needs.
11. The whole subject is a challenge to the engineer.

The citation of these few paragraphs needs no further comment, because every man in municipal or regional planning and engineering fully appreciates the logic and philosophy contained. It seems to me that it is time to talk about and bring forth the practical application of regional planning, its problems, its procedure and requirements, in cold-blooded, practical engineering terms. When all is said and done, it all resolves itself to an engineering application plus a lot of super-co-ordination and team work.

WILLIAM J. FOX,
Chief Engineer,
Regional Planning Commission,
County of Los Angeles.
Los Angeles, Calif.,
Nov. 22, 1928.

* * * *

Sir—I have only just had an opportunity to look over the article in *Engineering News-Record* of Oct. 4 on Regional Engineering. The subject is important and the article is excellent. I hope that the discussion of the general topic will be continued in *Engineering News-Record*.

I am lecturing on the general subject of regional planning at Dartmouth College this week, and it has aroused fresh interest in my mind.

JOHN NOLEN,
City Planner.
Cambridge, Mass.,
Dec. 5, 1928.

Determining Moisture Content in Aggregates

Sir—The method outlined by Mr. Dunagan under the heading "New and Simple Method for Determining Moisture Content in Aggregates," in your issue of Nov. 15, 1928, may, unless great care is taken, lead to rather large errors. The true value of S_1, the weight of sample saturated and surface dry, for sand, is in practice very difficult to determine as close as ½ per cent by weight of the sample. This makes possible an error of 2 to 5 grams in the value of x. As the usual range of values of x is 15 to 40 grams, using a 500-gram sample, this is rather a large error. Variations in specific gravity may easily cause even larger errors. As these errors can be cumulative, it is quite possible to have an error of 10 grams in the value of x obtained.

A careful study some time ago of this and similar methods led us to the conclusion that so far as sand is concerned the most dependable method is to determine absorption and then to obtain total moisture at intervals by drying to constant weight. By using an iron pan of such size that the sample can be spread in a layer less than ¼ in. thick, this method is about as quick as any. An alcohol stove or "canned heat" makes a convenient source of heat if no other is available.

It should be observed that with materials of noticeable absorption the values of G_s will be considerably different from the apparent specific gravity. If we call the true value G, and the amount of absorbed water in S_1 be called a, then

$$G_s = \frac{S_1}{d_1} \text{ ; but } G = \frac{S_1 - a}{d_1}$$

In the case of rather porous aggregates, such as sandstone, many limestones, Haydite or slag, the value of a may be from 3 to 6 per cent of the weight of the sample. No error has been made in using G_s to derive the equation for the value of x; but unless the distinction is clearly understood, values of G_s and G are likely to be used interchangeably and so lead to large errors.

The method suggested by Mr. Dunagan is much the simplest and fastest for determining the added absorption of porous coarse aggregates which are dry or contain less moisture than the total absorption, providing the material is reasonably uniform. However, the sample should be allowed to soak at least twenty minutes before reading the value of W_2.

We have been using this method with a slightly different equation which is a little easier to derive: If V is the volume of solids in sample S_2,

$$S_2 = W_2 + V + x$$

$$V = \frac{S_2 - x - a}{G}$$

substituting and solving, $x = S_2 - \dfrac{W_2 G - a}{G - 1}$

or using G_s, $x = S_2 - \dfrac{W_2 G_s}{G_s - 1}$

In using this method successfully its possible errors must be clearly understood and guarded against.

H. C. MCCALL,
Chief Engineer,
Concrete Engineering Service Company.
Cleveland, Ohio,
Dec. 7, 1928.

News of the Week

President Approves Bill Authorizing the Black Canyon Dam

A Sum of $165,000,000 Approved for a Dam and Power House and All-American Canal

By Paul Wooton
Washington Correspondent Engineering News-Record

THE PRESIDENT on Dec. 21 affixed his signature to the Boulder dam bill, which authorizes the expenditure of $165,000,000 for the construction of a high dam in the Colorado River at Black Canyon.

The act contains the principal features of the recommendations of the Bureau of Reclamation. The site is that which the bureau recommended. The capacity of the reservoir was fixed at that worked out by the engineers of the bureau. It also was their suggestion that the power revenues be applied on the capital expenditures by the government. The bill includes the All-American canal which is to be built and paid for under the provisions of the reclamation law.

The amendments to the bill are regarded as helpful. This applies particularly to the conditional contribution of $25,000,000 of federal funds for flood control, as does the arrangement for payment to Arizona and Nevada to take the place of taxes. The belief among Reclamation Bureau engineers still is that the cost can be held below the amount estimated by the Sibert board.

At least a year must pass before construction can be begun. It is believed that length of time will be required for ratification of the preliminary surveys and to handle the competitive bidding for the power. It is expected that $50,000 will be carried in the second deficiency bill to take care of preliminary studies and the preparation of plans which can go forward in the meantime.

Regardless of what may be done with the All-American canal as a whole, it is certain that the Imperial Valley interests will want the work pushed on that portion of the canal from the Colorado River to the international boundary, so as to lessen the expenditure necessary for silt removal and to avert the cost of maintaining a temporary dam in the canal. The studies of the canal could begin at once. The money expended could be reimbursed under the provision in the reclamation act.

The steps for carrying out the development have been outlined by the Bureau of Reclamation as follows:

1. Ratification of the compact.
2. Preparation of plans and estimates for the dam and power house.
3. Contracts for power revenues.
4. Building of the dam by the government and building of the power house by the government or private parties.
5. Building of the All-American canal from the headgate down to the international boundary.
6. Building the remainder of the canal if satisfactory agreement with Mexico cannot be secured, or if the irrigation interests that are to pay for this canal desire it to be constructed and enter into a satisfactory contract which will assure the payment of the costs.

Before the dam can be begun or contracts made for the power house the offers for power must be large enough to repay the money spent by the government, with 4 per cent interest, less the $25,000,000 flood-control item. If such contracts are secured, then the next step would be to provide for the construction of the dam, and this would probably be under a contract. If the Imperial and Coachella valleys are prepared to repay the entire cost of the All-American canal, contract for that canal also could be let.

Start Work on Biloxi Causeway

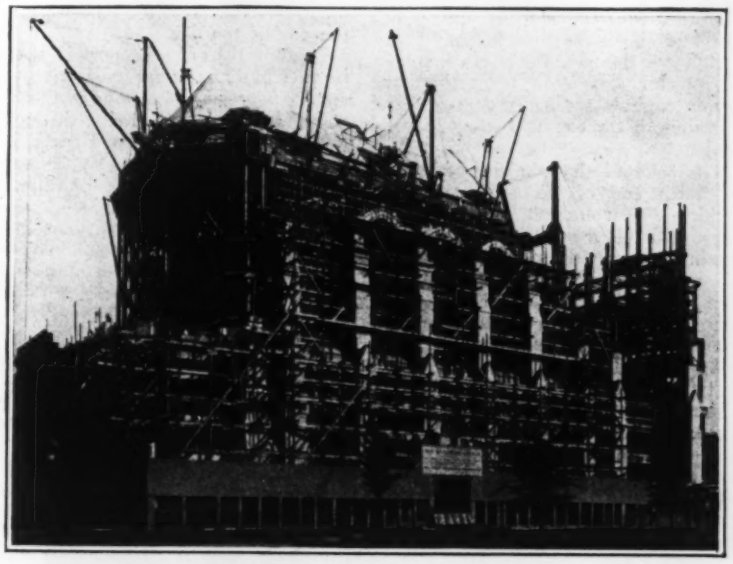
The first step in the construction of the Biloxi-Ocean Springs bridge in Mississippi has been taken with the establishment of a concrete-molding plant for the manufacture of piling for the structure, which will cost approximately $850,000. The work will be done by the Fuller Construction Company, Memphis, Tenn.

Burning Scaffolding Damages N. Y. Church Under Construction

Cause of Fire Undetermined—Extent of Damage Doubtful Pending Tests of Steel Frame

A DISASTROUS and spectacular fire at 7:30 p.m. on Dec. 22 swept through the wood scaffolding being used to erect the interior stonework and the ceiling of soundproof tile in the Riverside Church, New York City, and damaged the partly completed structure to an amount of several hundred thousand dollars. Although the major damage is believed to have been confined to the interior stone facing and that part of the cut stone decorative work that was in place, parts of the structural steel frame were exposed to the action of the flames and it is not possible until further investigation to determine whether or not these were damaged. The church, popularly known as the Rockefeller church, has been actively under construction during 1928 and was scheduled for completion in April, 1929. Its estimated cost was $4,000,000. The architects, Henry C. Pelton and Allen & Collens; the contractors, Marc Eidlitz & Son; the structural steel designers, Lange & Noska; the steel erectors, the Taylor-Fichter Steel Company, and engineers for the insurance underwriters are investigating.

To date they have been unable to fix



THE RIVERSIDE CHURCH THREE MONTHS BEFORE THE FIRE

The steel of the nineteen-story tower at the south end is just rising above the main part of the structure at the eighth floor. At the time of the fire the tower steel was erected about eight stories above this point, the exterior stonework of the apse and nave was in place and the tower had been inclosed up to the ninth floor. All the exterior scaffolding had been removed.

the probable cause of the fire. A report will be made as soon as possible on the condition of the structure and the extent of the damage.

The Riverside Church is unique in design. Its architecture upon completion will, in outward appearance, be that of the wall-bearing and buttressed Gothic churches of thirteenth-century France. Actually all of the stonework, both outside and inside, is carried on a structural steel frame. The structure, which is rectangular in plan, 100 ft. wide by 265 ft. long in a north-south direction, includes as its essential parts a semicircular apse on the north end, a nave 170 ft. long open from street level to its pointed arches of sound-deadening tile 110 ft. above and a nineteen-story tower 65x95 ft. on the south end, rising some 300 ft. above the street. A reinforced-concrete slab at the eighth floor level runs the entire length of the nave and apse, and it is below this that the ceiling arches are hung. A nave balcony undercuts the tower for about 45 ft., so that part of the tower above the eighth floor is carried on a heavy truss of 69 ft. span set between the eighth and tenth floors. This, together with its auxiliary framing and supporting columns, constitutes the heavy steel detail in the building. The structure inside and out is faced with limestone and granite.

At the time of the fire the stonework on the exterior of the nave and apse was completed and the stonework of the tower had been placed to only about the ninth floor. The heavy truss and steel framing were therefore exposed to action of the flames. The stonework of the interior of the nave and apse was practically complete and scaffolding was in place for placing the tile ceiling. The structural steel of the tower had been completed to about the sixteenth floor.

The major damage to the structure was confined to the area under the reinforced-concrete slab at the eighth floor and above the first balcony about 35 ft. above the nave floor. In this area the interior stonework is cracked, the column capitals are badly damaged and the window tracery is broken beyond repair.

It is believed that the fire started in the north end of the structure on a working platform about 55 ft. above the floor. This platform was of steel beams framing between the nave columns and was covered with planking. A wind from the northwest carried the flames from the north to the south end of the structure, where the partly inclosed tower acted as a flue which received its draft from the window openings.

The cause of the fire is yet undetermined. The contractor had taken what he believed to be all necessary precautions against fire. A timeclock system had been installed connected to the National District Telegraph Company's wires. Eight clock stations were placed in the building in various locations as high as the tenth floor in the tower. One watchman made the round of these clocks every two hours. It required about 1¼ hours to punch all of the eight clocks. Two standpipe lines had been carried up with the work; one of these was in the south end, the other in the north end of the structure. A total of 38 chemical fire extinguishers were placed in various parts of the building. Two small fires previously had caused the contractor to take special precautions against rubbish and trash accumulations. It is reported that there was a standing order to remove all rubbish every evening.

No salamanders had been used in the building, heat being supplied by piped steam from fuel oil boilers in the basement. No riveting had been done on the day of the fire.

Pending the official report all that can be said is that the fire evidently started on the working platform at the north end of the building, swept through all the scaffolding and burned itself out in the tower on the south. By taking this course it exposed the steel ceiling ribs of the nave and the steelwork of the tower above the eighth floor to unusually high temperatures. The condition of the steel is one of the major points under investigation.

Acme Photo

BLAZING TOWER OF THE RIVERSIDE CHURCH

The fire is supposed to have started at the opposite end and swept through the length of the structure. Note that flames are confined to the upper part of the building. At the top the flames are rising out of the flue-like tower. Note exposed steelwork at this level, where heavy truss and girder framing is located.

Open New Road Near Pittsburgh

A section of a new road along the cliff south of the Ohio River, paralleling Neville Island, was opened to traffic by Allegheny County, Dec. 15. The section completed has a length of 11,737 ft. with a reinforced-concrete pavement 18 ft. wide. This is a section of the Fleming Park road project which, when completed, will be an important link in Allegheny County's highway system. It will eliminate the necessity of using the Neville Island road with its seven railroad grade crossings.

Part of Holland Tunnel Approach Highway Opened

Two sections of the new approach highway to the Holland Tunnel in New Jersey were opened to traffic Dec. 16. These are a portion of the elevated viaduct through Newark and the covered-cut section through Jersey City. The completed project, which was described in *Engineering News-Record* Jan. 5, 1928, p. 4, will carry through traffic from the Holland Tunnel from Jersey City to Elizabeth, N. J., a distance of approximately 13 miles, about 7 miles of which will have no grade crossings with other highways.

Dallas Pipe Contract Sustained

An injunction to restrain the city of Dallas, Tex., from executing a $1,264,000 contract with the U. S. Cast Iron Pipe & Foundry Company for a water-distribution system has been denied by Judge Claude McCallum of the U. S. District Court. The suit was brought by L. J. Haralson, a citizen of the city. The proposed contract was attacked on three main grounds: alleged impropriety in the advertising for bids; the inclusion of chemical analysis requirements which it is claimed illegally stifled competition, and supposed irregularities in the form in which the bid of the company was submitted. The judge upheld the defendant on all three points.

New York City Declines Offers to Develop Long Island Wells

Proposals submitted by the Titus Water Engineering Corporation to the Board of Estimate and Apportionment of New York City in which it was offered to develop a supplementary water supply for New York City from wells to be drilled on Long Island have been ordered filed by the board. This action in effect takes the proposal from the calendar. Details of the offers will be found in *Engineering News-Record*, Oct. 21, 1926, p. 680, and Dec. 9, 1926, p. 972. A report to the Board of Estimate by the Board of Water Supply advised that a supplementary system should be provided, but under competitive bidding and not by acceptance of one of the several offers to the board.

Richmond - San Rafael Toll Bridge Hearing Scheduled

The U. S. War Department will hold a hearing in San Francisco Jan. 3 to consider the application of O. H. Klatt, president of the American Toll Bridge Company, for permission to erect a bridge across San Pablo Strait, between the northern part of San Francisco and San Pablo bay. This is generally known as the Richmond-San Rafael bridge. It is stated that construction work will begin as soon as a permit has been granted by the War Department. Charles Derleth, Jr., is consulting engineer on this structure.

Wanaque Aqueduct Contract Let to T. A. Gillespie Company

Eleven bids, from nine bidders, for the Wanaque aqueduct were received by the North Jersey District Water Supply Commission on Dec. 20. The contract was awarded the same day for $5,127,628 to the lowest bidder, the T. A. Gillespie Company, Inc., New York City. This was for 74-in. lock-bar steel pipe, to be fabricated by the East Jersey Pipe Company at Leetsdale, Pa. There will be about 161,000 ft. of this pipe, including twin conduits at the upper end. The contract includes various accessories.

Bids were invited on seven different classes of steel pipe, the variations centering in the type of joints used. The size base was 74 in., with differentials up to 78 in. for different types of riveting. (See *Engineering News-Record*, Dec. 13, 1928, p. 889, for abstract of specifications, and the Business News Section of this issue for grand totals of bids and for unit prices of the two lowest and of the highest bids.) There were no bids on hammer-welded or on button-head riveted pipe. Three bidders tendered on lock-bar pipe, one on 74-in. countersunk-riveted pipe in 30-ft. courses and one on the same kind of joints in 7½-ft. courses. There were six bids on 76-in. countersunk-riveted pipe in 7½-ft. courses, but with countersinking for part of the joints only. One bidder tendered on lock-bar and on the two classes of countersunk pipe just mentioned. The next to the lowest bid was $5,760,255 for 74-in. countersunk-riveted pipe, in 30-ft. lengths, from Clifford F. McAvoy, Newark, N. J., the pipe to be supplied by the New York Shipbuilding Company, Camden, N. J. The fourth, sixth, seventh, ninth, tenth and eleventh bids were for 76-in. countersunk-riveted pipe in 7½-ft. courses, the highest of these being $7,718,406, from Joseph Sigretto & Sons, New York City, the pipe to be supplied by the American Locomotive Works.

Arthur H. Pratt is chief engineer and Morris Sherrerd is consulting engineer to the North Jersey District Water Supply Commission. A few months ago the engineering work of the aqueduct was put in charge of Fuller & McClintock, New York City, who made some changes in the plans and specifications previously drawn.

New Maryland Road Head Dies

News of the death on Dec. 19 of Oscar F. Lackey, newly appointed head of the Maryland State Road Commission, was received soon after the closing of our news pages for Dec. 20, in which appears the notice of Mr. Lackey's appointment. As noted in last week's issue, Mr. Lackey had been engaged in municipal engineering in Cuba for five years, had been president of the Baltimore Harbor Board from 1906 to 1915 and in 1918 became supervising engineer in connection with the construction of port terminals in Boston, Philadelphia, Brooklyn, Norfolk, Charleston and New Orleans. In 1921 he returned to Cuba to design a large sugar terminal, and in 1922 became vice-president and general manager of the Colorado Springs Light, Heat & Power Company. Later he returned to the Baltimore Municipal Department of Transportation, leaving this in 1927 to take up consulting work. His appointment as head of the State Road Commission was to have taken effect in the near future.

Charles A. Morse Retires From Rock Island Lines

Charles A. Morse, chief engineer of the Rock Island Lines since 1913, will retire from service on Dec. 31, having reached the age of 70. Mr. Morse was born at Bangor, Me., on Jan. 1, 1859, and was graduated at the University of Maine in 1879. His first railroad experience was as instrumentman on the Chicago, Burlington & Quincy Railroad in 1880; he was a division engineer on the Mexican Central Railway from 1881 to 1884, when he returned to the Chicago, Burlington & Quincy as division engineer. In 1886 he went to the Atchison, Topeka & Santa Fe Railway as division engineer and was advanced successively to assistant to chief engineer, in 1901; principal assistant engineer, 1902; acting chief engineer, 1903; assistant chief engineer, 1904; chief engineer, 1906, and chief engineer of the entire Atchison, Topeka & Santa Fe Railway system in 1909. Then in 1913 he went to the Rock Island Lines as chief engineer, which position he has held until his retirement. During the war he was assistant director of engineering and maintenance for the U. S. Railroad Administration and a member of the board of review of the construction department, U. S. Army.

Mr. Morse is a member of the American Society of Civil Engineers, past-president of the American Railway Engineering Association and past-president of the Western Society of Engineers.

Hetch Hetchy 16-Mile Tunnel Holed Through

The last rock barrier in the 16-mile Foothill tunnel of San Francisco's Hetch Hetchy water project has been holed through, and lining work is being rapidly pushed. The final section was 4 miles in length, and the two headings met with an error of less than 1 in. Considerable difficulty was encountered from intercepting water under pressures from 350 to 400 lb. per sq.in. This leakage was overcome by means of circumferential grout holes. The Foothill tunnel extends from Moccasin Creek power house to Oakdale portal, a total length of 15.85 miles. It is built to carry 470,000,000 gal. of water per day. Work was started in March, 1926, from two portals, two shafts and two adits. Contractors on the work were A. Guthrie & Company and Connolly & DeLuca.

Extra Meeting to Be Held By N.E.W.W.A. in Hartford

Announcement was made at the luncheon meeting of the New England Water Works Association in Boston Dec. 11 that the executive committee had decided to hold an extra meeting next April, probably at Hartford, Conn. The practice in years past has been to confine the meetings of the association to luncheon meetings monthly from November to March, a June outing of a single day, and the annual convention in September.

The report of the committee on cross-connections was extensively discussed. It included a new resolution which was ordered sent to letter ballot after unsuccessful attempts for its amendment were made, as was stated in last week's issue. A paper on reforestation carried out by the Water Board of Winchester, Mass., was read by Charles E. Kendall, a member of the board. It dealt chiefly with the theory that the yield from water-collecting areas is heavier when they are covered with evergreens than with hardwood and advocated the displacement of hardwoods, when existing, by evergreens.

Competitive Franchise Granted Gas Company in Missouri

Competition in furnishing natural gas to Kansas City, Mo., is provided by the recent approval of the application of the Industrial Gas Company of Missouri for permission to supply natural gas to industrial consumers in competition with the Kansas City Gas Company. The latter has hitherto held a monopoly of the gas business in that city. The application was fought by the Kansas City Gas Company on the ground that it was entitled to protection as a regulated monopoly. The Missouri Public Service Commission, in overruling this motion, stated:

> It may be said that the prevailing policy in state regulation of public utilities is to favor regulated monopolies rather than to encourage competition, but this is by no means an absolute and unvarying rule. In its application it is designed to protect and promote the best interests of the public, and when it fails to do this there is no reason why this policy should be followed.

Salt River Project Payment Made on Date Due

Payment of $609,553.67 to the U. S. Bureau of Reclamation by the Salt River Valley Water Users' Association has unusual significance, in that this is the first annual payment of the project which has been made when due. This sum, together with two previous payments made in July and October, brings the total of payments this year to very nearly $1,759,000. The Salt River Valley Water Users' Association originally owed the government $10,166,000 and has to date repaid more than half. The reduction in this debt during the current year has amounted to about 30 per cent.

Short Sanitation School to Be Held in Texas

The Texas Section, Southwest Waterworks Association, in co-operation with the Agricultural and Mechanical College of Texas, the State Department of Health, and the City of Bryan, will hold a short school on sewage and waterworks practice Jan. 14-25, 1929, at Bryan, Tex., and at the Texas Agricultural and Mechanical College. Arrangements are in charge of Prof. E. W. Steel, College Station, Tex., and V. M. Ehlers, secretary, Texas Section, Southwest Waterworks Association, Austin, Texas.

Bill to Register Engineers Before Next California Legislature

The California Engineers' Registration Association, organized to secure the passage of a bill by the California legislature requiring the registration of engineers, on Nov. 15 had a total membership of 640 and its committees had completed the drafting in tentative form of a proposed registration law. This draft is to be circulated among engineers to secure comment and criticism that might lead to its improvement before drawing up the bill in the final form that will be submitted to the 1929 legislature. Donald M. Baker is president of the association and Pecos H. Calahan, 366 West Elk St., Glendale, Calif., is secretary-treasurer.

Engineers' licensing or registration laws have several times been proposed to previous California legislatures, but each time the measure has failed to become a law. In its tentative form the new bill is entitled "An act regulating the practice of professional engineering; providing for the creation and establishment of a state board of registration for professional engineers; granting certain powers to and prescribing the duties of said board; providing for the examination and registration of professional engineers and providing penalties for the violation of this act."

"Professional engineer" is defined to include all subdivisions of chemical, civil, electrical, mechanical and mining engineering and the bill prohibits professional work in any of these branches without registration. The examining board is to have five members, appointed by the Governor, the term of office to be four years and the compensation to be not more than $25 per day plus expenses. The board would have a secretary with a salary not to exceed $3,600 per annum.

Some of the other provisions of the bill are as follows: To be eligible for registration an applicant must be at least 25 years old, of good character, and must have either (1) six years of practice in responsible charge of engineering work or (2) a diploma from an engineering school of recognized standing plus two years practice in "responsible charge."

Engineers from other states would be allowed to practice within California without registration provided their professional work in California was not to extend beyond 30 days and provided the state whence they come has registration requirements not lower than those of the California act.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Survey Funds Limited—Power Projects Await Approval—New Orleans Bridge Still Opposed

THE Interior Department appropriation bill passed the Senate on Dec. 20 with the addition of a few minor amendments. Nothing is foreseen to prevent the final acceptance of the bill in essentially its present form. Provisions for bureaus engaged in engineering activities were as follows: Geological Survey, $2,085,800; total from reclamation fund, $8,760,000, and numerous items under the Indian Service and National Park Service.

Of the Geological Survey appropriation, the sum of $635,000 was allotted to topographic surveys, to which the sum of $45,000 was added by the Senate for a survey of the proposed Shenandoah National Park in Virginia. The increase over the current appropriation of $505,000 is understood to cover work on the public domain. Whatever might have been used in extending general activities is swallowed up by the Welch act salary increases which became effective last July. Thus, it is pointed out, the Temple act, which was designed to complete rapidly the topographic map of the country and which would now be furnishing $2,000,000 per year, is as yet interpreted to mean dollar-for-dollar co-operation with the states, and that on a limited scale.

The main item for stream-gaging and water-supply investigations was set at $275,000, of which $50,000 is to be used for base stations at Lees Ferry, Ariz., and other points on the Colorado River. Of the total, $150,000 must be used in dollar-for-dollar co-operation with states. Only $75,000 remains free for non-co-operative work. The increase in the total of $28,000 over the last appropriation is wiped out by the Welch act, leaving the status of the water resources branch unchanged.

River and Harbor Work

Disagreement with the President's recommendation that river and harbor authorizations be suspended until the country can see its way out of the expense of flood control and the appropriations for the $243,000,000 worth of river and harbor projects which already have been authorized is being voiced by many members of Congress both inside and outside of the legislative chambers. The principal argument advanced against the President's recommendation is that authorizations for river and harbor work should proceed regularly. To allow long intervals between bills, it is argued, makes for confusion and waste, such as resulted from the suspension of the regular public buildings bills.

Hydraulic Laboratory

Efforts by fellow legislators and by prominent engineers to arouse the interest of Chairman Dempsey, of the committee on rivers and harbors, in the hydraulic laboratory bill before his committee thus far have been unsuccessful. The bill passed the Senate at the last session. Shortly thereafter hydraulic engineers from various parts of the country appeared before the committee. In a formal communication just sent Mr. Dempsey the American Engineering Council points out that the authority granted the Corps of Engineers to establish such a laboratory "does not satisfy the need for a national hydraulic research laboratory under the Bureau of Standards," where staff men trained in the various sciences are available to work on the hydraulic problems of the Geological Survey, Federal Power Commission, Reclamation Bureau and other agencies, as well as on those of private interests willing to pay for the service.

Railroad Consolidation

As Congress has made little progress since 1925 in providing such additional legislation as would facilitate the task of consolidating the railroads, the Interstate Commerce Commission evidently has decided to do the best it can under existing law and is proceeding actively with its plans to that end. The commission has enough authority to deal with the situation and the commission as now constituted seems willing to undertake the task. Relatively unimportant additional action by Congress would make the job an easier one. It now is clear, however, that no railroad legislation may be expected at this session.

Power Applications

The Inland Power & Light Company, of Portland, Ore., has applied to the Federal Power Commission for a preliminary permit covering a 233,000-hp. project on Lewis River near Vancouver, Wash. It is proposed to develop the power resources of the stream progressively. At the Ariel site, 17 miles above the confluence of the Lewis and Columbia rivers, it is proposed to construct a dam 200 ft. high. At a point 32 miles from the mouth of the Lewis River it is planned to erect a dam 230 ft. high. Thirteen miles farther up the river, at the Swift site, another 200-ft. dam is projected, along with a 5-mile tunnel. At the Muddy Creek site, 12 miles above the Swift site, it is proposed to erect a 150-ft. dam and to construct a 3-mile tunnel. The applicant is closely associated with the companies serving the Portland area and with the Washington Irrigation & Development Company, which holds a license for the development of the large project at

Priest Rapids. Under the terms of that license work must begin not later than March 1.

The Gasconada River Power Company, of Kansas City, has applied for a preliminary permit covering a project on the Gasconada River near Rolla, Mo. It is proposed to construct a dam which will furnish a head of 90 ft. and create a reservoir of 400,000 acre-ft. capacity. Some 6,000 hp. of primary power will be available, it is estimated. The applicant plans to develop this site in connection with a project on the lower part of the Gasconada River covered by a preliminary permit issued the company Aug. 21 of this year.

The Mountain States Power Company, of Albany, Ore., has applied for a license covering a transmission line 66 miles long to connect Lovell and Worland, in Wyoming.

John A. Shafer, of Indianapolis, has applied for a preliminary permit covering a project on Rockcastle River in Pulaski County, Kentucky. He proposes to construct a dam 250 ft. high which will create a reservoir having 40 square miles of area. It is planned to install 36,000 kw. This application conflicts with one previously submitted by L. E. Bryant.

Frederick C. Rockwell, of Carmel, Calif., has applied to the Federal Power Commission for a preliminary permit covering a project on the North Fork of Eel River in Trinity County, Calif. He proposes to construct a dam 300 ft. high and 665 ft. long, creating a reservoir with a capacity of 137,000 acre-ft. Primary power to the extent of 16,000 hp. will be made available, the applicant estimates.

The Fargo Engineering Company, of Jackson, Mich., has applied for a preliminary permit covering a 2,000-hp. project on Kalamazoo River in Allegan County, Michigan. A previous application by this company covered the entire head available between the dam side and the city of Allegan. This was rejected in favor of the municipal project which utilizes half of the available head. The present application covers the remaining power resources in the stream.

Opposition to New Orleans Bridge

Strong disinclination to grant a permit allowing the construction of a bridge over the Mississippi within the harbor limits of New Orleans continues to be evident at the Corps of Engineers, despite the large amount of additional data which have been laid before them. There are unofficial suggestions that the connection should be made by the means of a tunnel or that the bridge be located above the city. General Jadwin's stand against bridges across the major navigation channels of the country has been firmly taken, but in the event of an exception at New Orleans, where there is ample room for the harbor to expand downstream and through the industrial canal into Lake Pontchartrain, it is believed certain that he will insist on a clearance of more than 135 ft.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 14-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; annual meeting, New York, N. Y., Jan. 16-18.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

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THE CORNELL SOCIETY OF ENGINEERS will hold its annual banquet in New York City, Jan. 18. Edward C. M. Stahl, Brooklyn Edison Company, Brooklyn, N. Y., is secretary.

THE ALBANY, N. Y., SOCIETY OF ENGINEERS held its annual meeting Dec. 18. The following officers were elected for 1929: President, James E. Hewes; vice-presidents, Albert C. Richards, William R. Davis and Grandison G. Underhill; secretary-treasurer, John W. Henry.

THE LOUISIANA ENGINEERING SOCIETY at a recent meeting elected F. H. Fox, of Tulane University, as president. Other officers are: Vice-president, J. M. Todd; secretary, Frank Muth.

THE NEW JERSEY SOCIETY OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS has accepted the resignation of Edward H. Rockwell as president. Mr. Rockwell, until recently, was dean of the Engineering College of Rutgers University, but has now accepted a similar position at Lafayette College, which will prevent him from continuing his active interest in the society. Howard B. Keasby, first vice-president, has assumed the position of president.

THE CLEVELAND ENGINEERING SOCIETY is presenting a night course in cement and concrete which is open to any one interested. Lectures and laboratory sessions are held on Wednesday evening. The total enrollment in the course is now 133.

Personal Notes

PHILIP DONNELL, for the past five years head of the engineering department of the University of Arizona, is now dean of engineering at Oklahoma Agricultural and Mechanical College.

WILLIAM GEORGE MURRIN, member of the Engineering Institute of Canada, will become president of the British Columbia Electric Railway Company, Ltd., on Jan. 1.

GEORGE W. ABBOTT, formerly manager of the Railway Engineering & Construction Company, Boston, Mass., and A. J. CONNOLLY, formerly with the Union Freight Railroad, have formed the Abbott-Connolly Construction Company, with offices in Boston. The new firm will offer the same service formerly rendered by the Railway Engineering & Construction Company, whose business has been discontinued due to the recent death of J. E. Fitz Gerald, president.

THOMAS G. MCCRORY, of Seattle, Wash., district engineer for the Washington State Highway Department, has been appointed chief assistant highway engineer. Mr. McCrory succeeds Oscar A. Piper, who recently resigned to become first assistant in the office of W. D. Barkhuff, city engineer of Seattle.

EDWIN H. ROGERS, for the past five years chief engineer of the Metropolitan Planning Division, Boston, Mass., is now director of park engineering for the Metropolitan District Commission, succeeding the late John R. Rablin. Mr. Rogers was formerly city engineer of Newton, Mass., holding that post for fifteen years.

FLOYD SHOWALTER announces the formation of Showalter Associates, Inc., airport planners, architects and engineers, with offices in Detroit, Mich.

Obituary

RICHARD AUGUSTUS HALE, waterpower engineer, died in Lawrence, Mass., Dec. 17. He was a graduate of the Massachusetts of Technology, class of 1877. After four years of work on waterwheel tests and hydraulics for the Essex Water Power Company, of Lawrence, Mr. Hale returned to M.I.T. for three years of teaching. In 1877 he was once more employed by the Essex Water Power Company as an assistant engineer, remaining with this company for the remainder of his career. He recently succeeded the late H. F. Mills as chief engineer. Mr. Hale was a member of the American Society of Civil Engineers, the American Water Works Association and the New England Water Works Association.

FREDERICK LINCOLN STEVENS, well-known construction engineer, died in Seattle, Wash., Dec. 8. Mr. Stevens was born in Groton, Mass., on April 19, 1865. He went to Seattle with his family in 1906. He was connected with H. C. Henry in the capacity of Western superintendent during the construction of the Chicago, Milwaukee & St. Paul Railway. Since that time he had been superintendent for the Henry & McFee Contracting Company. During the construction of the large piers at Bremerton Navy Yard he was superintendent of the casting yard. For many years he had been considered an authority on construction costs and methods.

JESSE W. FOX, 76, died Dec. 12 at his home in Salt Lake City, Utah. Mr. Fox studied engineering at the old Deseret University and later took an active part in building what is now part of the Oregon Short Line Railroad, the Salt Lake City Canal, and the South Jordan and Utah canals. He had also held the positions of city surveyor and county surveyor.

Construction Equipment and Materials

New York City Builders Prepare Standard Specifications

Standard specifications for the general construction trades in the building industry have been completed by the New York Building Congress through its committee on standards and will soon be available for distribution to architects, builders and other interested persons. The work of preparing the specifications, which has occupied several years, was shared in by subcommittees representing architects, contractors, subcontractors, manufacturers and labor. The completed specifications are divided into two parts, A and B. Part B establishes standards for all materials and workmanship which could enter into the work of any trade division and any type of building. Part A is a specification written by each architect for each job, with references by numbers to the paragraphs or clauses in Part B which define the quality of materials and workmanship. The final form of the specifications as issued is the work of H. R. Dowswell, of the office of Shreve & Lamb, architects, who was selected to edit the specifications. A working test was given by applying the standards to the bidding on a large building in one of the Southern states. After the reception of bids for this structure letters were written to all of the general contractors from whom bids had been received, explaining that the specifications were based on the New York Building Congress standards and asking for comment. It is stated that the results obtained were very satisfactory.

Although the work is not complete, all of the general construction trade divisions have been approved and are ready for printing, and specifications will be ready about Feb. 15, 1929, in 38 classifications, with more to follow. They will be distributed by the New York Building Congress through its office at 101 Park Ave., New York City.

Carey Order Reversed by Court

A decision of the U. S. Circuit Court of Appeals has reversed an order of the Federal Trade Commission directed against the Philip Carey Manufacturing Company and the Philip Carey Company, in which these two companies were directed to refrain from certain practices which the commission found were in violation of the Federal Trade Commission act of September, 1914, as constituting unfair competition. More specifically, the order of the Federal Trade Commission directed the companies to desist from: (1) Employing or using any system of espionage whereby officers, agents and employees obtain or seek to obtain information as to facilities, capacities, operations or customers of any competitor; (2) circulating, representing or publishing among prospective purchasers of pre-formed bituminous expansion joint any false or misleading statement concerning the ability of any competitor to fill orders or make deliveries; (3) circulating or publishing among prospective purchasers of preformed bituminous expansion joint any false or misleading statement concerning the acceptableness or adaptability for the use intended of the product of any competitor; and (4) circulating or publishing among prospective purchasers of pre-formed bituminous expansion joint any false or misleading statement concerning the financial standing, business or business methods of any competitor.

The court, in considering the orders of the commission, held that the practices from which the two companies were ordered to desist did not amount to unfair competition and that the evidence did not sustain the findings of the commission.

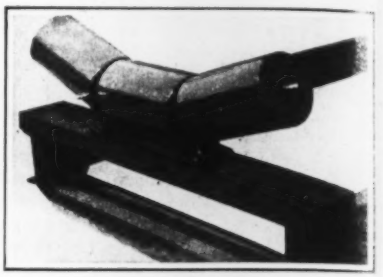
Tractor Builders Acquire Road Machinery Company

Acquisition of the business and facilities of the Russell Grader Manufacturing Company, Minneapolis, Minn., by the Caterpillar Tractor Company, San Leandro, Calif., has been announced by the latter firm. The Russell line of roadbuilding machines will henceforth be manufactured by the road machinery division of the Caterpillar Tractor Company at the plant formerly occupied by the Russell company at Minneapolis. Sales will be handled by the regular Caterpillar dealer organization.

New Developments

Ball-Bearing Idlers Carry Large Lubricant Reserve

Many features of design unite to give long life and efficiency in operation to a new model of belt conveyor idler produced by the Chicago Automatic Conveyor Company, Cicero, Ill. These idler pulleys are mounted on a unit support in order to keep them in perfect alignment. The mounting also serves as a grease reservoir with an unusually large capacity which makes it possible to run from three to six months without attention. The bearings are protected from dust and grit by a labyrinth grease seal, which also prevents the grease from being thrown on the carrier belt. Lubrication, when necessary, is made easy by Alemite



fittings or other types of high-pressure fittings.

In order to eliminate the necessity for adjustment, ball bearings are used instead of roller bearings. The pulleys are spaced ½ in. apart to avoid creasing the belt, and are made of heavy steel tubing with electrically welded ends flush with the base of the pulley, eliminating dust pockets.

Portable Pump Unit Driven by Outboard Motor

Powered by a light-weight gasoline engine which has already been in use a number of years as an outboard motor for boats, a new portable pump unit is now being produced by the Johnson Motor Company, Waukegan, Ill., which has a rated capacity of 195 g.p.m. with a head of 8 ft., or 175 g.p.m. under a 14-ft. head. The unit consists of a power head connected to an impeller by a shaft inside of a hollow casing. The impeller is at the bottom of the shaft, so that priming is never necessary. A

strainer is provided to prevent clogging. Three different shaft lengths may be obtained: 8, 11 and 14 ft. The weights of these three outfits are 85, 92 and 99

lb. respectively. The motor itself weighs 24½ lb. An automatic shutoff protects the pump from any possibility of burning out when left unattended. In operation, a key is used to start the motor. This breaks a short circuit with the primary of the magneto and permits the motor to operate. As the water passes up the casing it deflects the diaphragm and compresses a rustless spring, releasing the key but permitting the motor to continue in operation. When there is no more water to be pumped, the pressure against the diaphragm is relieved, allowing the spring to expand and short circuit the magneto, thus stopping the motor.

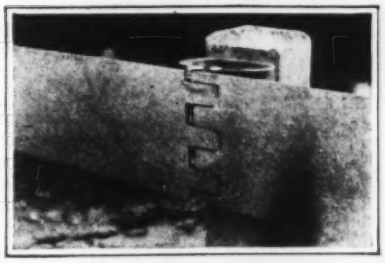
The motor is a three-port, two-cycle gasoline engine developing 2 hp. at 2,100 r.p.m. The two opposing cylinders fire simultaneously, thus reducing vibration. Cylinders have a bore of 2 in. and a stroke of 1½ in. Cooling is by a pressure-vacuum system, water being forced by the impeller through a 100-mesh carburetor screen and up a spiral seamless copper tube to the motor. It is pulled down and discharged by a 12-lb. suction created by the impeller. No greasing or special lubrication is required, as the motor is oiled by means of the gasoline mixture. Graphite bronze bearings are used in the drive shaft, lubricated by the drip from the motor.

Highway Guard Rail Designed to Minimize Impact Damage

Safety to vehicle and occupants and low cost of repair and maintenance are the two features controlling the design of a new type of guard rail now being introduced under the name of "Resiliflex." It is manufactured by the National Traffic Guard Company, Atlanta, Ga., and has already been installed along a number of miles of highway in the Southeast. In developing this rail it has been recognized that the primary purpose of a guard rail is to keep vehicles from leaving the roadway and, at the same time, to reduce as much as possible the damaging effect due to contact.

The Resiliflex rail consists of a steel plate 12 in. wide with connections so arranged that an absolutely smooth surface is presented to the highway, the rail itself being offset 5 in. from the line of supporting posts. It is installed at such a height that the only parts of the car which can come in contact with it are the bumper, wheels and hubs—parts which are best equipped to withstand shock. Attachment to the post is made through a spring hanger which gives the required offset and which permits the rail to yield under shock. It is claimed that it is practically impossible for an automobile to strike or damage a supporting post in the usual type of collision.

The rail is constructed of galvanized steel, and it is recommended that visibility be increased by the application of white paint. The smooth joint deflects a vehicle from one length of the rail to the next with no possibility of catching, and the rocker-shaped base



of the spring, which is fastened by a single heavy bolt to the post, permits the shock of the blow to be taken up by several springs instead of merely one. Fastening of the plate to the spring is accomplished by means of a single bolt at each end, which drops through openings in the ends of the plate in the same manner as the conventional door hinge.

New Publications

Rock Crushing—Traylor Engineering & Manufacturing Company, Allentown, Pa., describes in detail the construction and design of its bulldog jaw crusher in a 25-p. bulletin, No. 2099. A number of crushing plant layouts are given, also tables and charts for use in selecting proper sizes for definite services.

Cement—Lehigh Portland Cement Company, Allentown, Pa., in a recent bulletin gives a full account of a road-paving job using high-early-strength concrete. Full details are given regarding the design of the mix used and the compressive strengths attained.

Cast-Iron Pipe—Herbert Kennedy Company, Inc., New York, N. Y., has issued a 48-p. catalog of the cast-iron pipe and accessories produced by the Pont-a-Mousson cast-iron pipe foundries at Nancy, France, for which the Kennedy company is general agent in the United States. This pipe is produced to meet recognized standard specifications—namely, American Water Works Association, American Gas Association, British standard specifications and those of the city of Paris. All these are reviewed in the new catalog, as well as the "Class 150" cast-iron pipe now produced for the American market, which is guaranteed for a working pressure of 150 lb. per sq.in.

Lumber—National Lumber Manufacturers' Association, Washington, D. C., has issued a directory and production register. One section gives a list, by states, of subscribers of the association, their products and facilities. The second part of the book gives the same information rearranged and classified by products.

Centrifugal Pumps — Barrett, Haentjens & Company, Hazleton, Pa., has issued Bulletin 850, describing a method used to make suction lift centrifugal pumps automatic. The aim of the company has been to issue a publication which is technically correct and at the same time one that can be understood by the average mechanic or electrician. The book shows how the centrifugal pump can be started and stopped by a simple electrical switch, explains the way in which the pump is primed and describes devices for protecting the pump and electrical equipment against damage due to various adverse operating conditions.

Manufacturers and Trade Associations

CALENDAR

Annual Meetings

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 9-11, 1929.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C., annual convention, Cleveland, Ohio, Jan. 14-18, 1929.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; annual convention, Clevalnd, Ohio, Jan. 21-24, 1929.

AIRPORT CONSTRUCTION—A NEW FIELD FOR THE CONTRACTOR

This view, taken at Fort Wayne, Ind., is typical of the construction work now being done on many airports throughout the United States. The grading and paving of landing fields provide a new field of activity for the contractor. In this case trains of dump wagons hauled by Caterpillar tractors are transporting material dug by a Northwest shovel. The work is being done by the Arter Construction Company, of Fort Wayne.

The Business Side of Construction

An Assurance of Continued High Business Activity

American business and industry approach the new year under very favorable conditions. The year 1928 has witnessed record operations in almost every manufacturing group, especially during the last half of the year. General construction exceeded that of 1927 by more than 14 per cent; general employment has reached record proportions; the average weekly earnings of wage earners at the close of the year was the highest since 1920; corporation earnings advanced materially over those of 1927; retail trade exceeded that of the year previous by a wide margin; and the purchasing power of the American people, both urban and rural, was substantially increased. The year ended with industrial and general business activity above the estimated normal condition, which condition has been maintained practically throughout the entire year.

Many factors presage that whatever the course of business may be during the year 1929 as a whole, the first quarter of the year is almost certain to witness business and industrial activity of abnormal proportions. The outstanding favorable economic factors on the horizon as the new year opens are:

1. The election of Mr. Hoover. Corporations and large industries can now make their plans with certainty in regard not only to next year but for the next four years, for they can se continued prosperity inevitable with an economist and business leader at the helm.

2. A general optimism and confidence prevails throughout the country.

3. Material improvement in agricultural conditions. Farm products are on the most favorable basis for a decade, the value of nine leading farm products for 1928 being about 6 per cent greater than in 1927.

4. Decreased unemployment and a continued upward trend in wages with the cost of living remaining about stable, resulting in a widely distributed high consumer purchasing power.

5. Maintenance throughout the distribution branches of business of minimum inventories and quick turnover. Small stocks are in the hands of both wholesalers and manufacturers, a condition that presages a fairly constant volume of business during the next three months at the least.

6. Materially improved conditions in several industries that had been operating on a low scale during the first half of the year just closing.

7. A continuance of favorable underlying credit conditions even during a period of comparatively high money rates.

8. Continued high general construction of all classes. The value of contracts awarded for general construction projects during the last quarter of the year reached record proportions for the season, indicating continued high activity in this industry at least through the first quarter of the new year.

9. Increasing exports with an increased favorable trade balance.

10. A continuance of economic progress in foreign countries.

There are, however, some unfavorable factors which if they continue over a considerable time or become more forceful may lead to a disturbance of considerable importance. These adverse economic factors are as follows:

1. Frenzied speculation. Money has been diverted into the financial districts during the past few months in the extensive gambling in stocks, which credit should have been used for productive purposes.

2. High money rates. However, the ample resources of the Federal Reserve system make almost certain that there will be no lack of credit this year, though the rates at which this credit is obtainable remain at near present levels.

3. General trend toward price cutting to increase volume.

4. Depressed conditions in some of the basic industries such as coal and shipping.

5. Incomplete agricultural recovery.

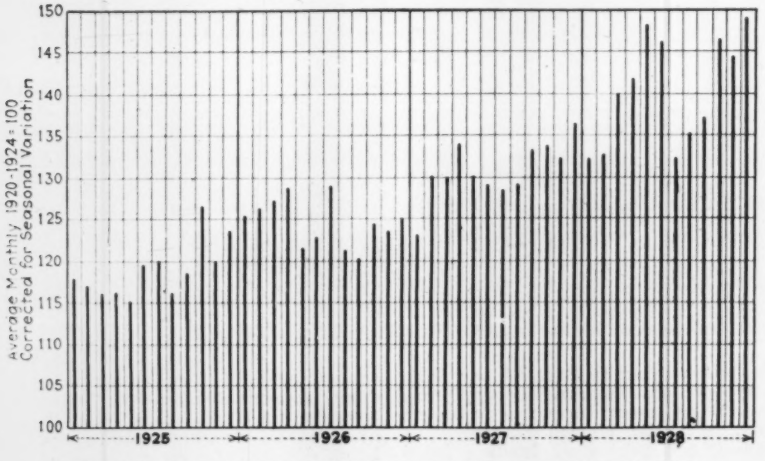
6. Extensive installment buying and selling and distribution costs.

7. Readjustments resulting from mechanization of general industry.

It is apparent that the favorable economic factors on the horizon far outweigh the unfavorable, and there is every reason to believe that American industry and business will experience continued prosperity at least for the first part of the the year. Beyond that point it is almost anybody's guess.

E. N.-R. Index Numbers

Cost		Volume	
Dec. 1, 1928	**210.16**	**November, 1928**	**251**
Nov. 1, 1928	209.46	October, 1928	363
Dec. 1, 1927	203.90	November, 1927	272
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913.....	100.00	1913.....	100



THE PAST YEAR HAS WITNESSED RECORD CHECK PAYMENTS

Awards Under Same Week Last Year

The week ended Dec. 24 witnessed a volume of contracts awarded on about the same level as for the week previous but about 31.2 per cent under that of the corresponding week of last year. The volume of contracts awarded for industrial buildings, however, was 51 per cent over that of the week previous and almost four times over the same week last year. This material gain in volume of industrial buildings was due to a $3,000,000 plant awarded by the Ford Plate Glass Company, located at Rossford, Ohio. A slight gain over the week previous was also recorded for commercial buildings, this gain being due to an increase in the number of million-dollar buildings compared with the week previous. The largest among these commercial structures was a $1,750,000 hospital at St. Louis. Projects for new streets and roads also showed a gain over the week previous, but were under last year.

The accumulated total for the year to date is $3,653,950,000, against $3,253,766,000 last year, a gain of 12.3 per cent over the same period in 1927. This is slightly under the rate of annual increase recorded during 1927.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Dec. 24, with some comparisons, total as follows:

(In Thousands of Dollars)

	Dec. 24, 1928	Dec. 18, 1928	Dec. 27, 1927
Buildings:			
Industrial.....	$8,167	$5,386	$2,102
Commercial....	33,100	30,143	37,971
Streets and roads..	4,593	3,992	6,880
Other construction.	9,677	11,996	33,649
Total.....	$55,537	$51,517	$80,602
Total, all classes, Jan. 1 to Dec. 24:			
1928.....			$3,653,950
1927.....			3,253,766